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the magazine of the Royal Ontario Museum

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Cat. No. 7 Andrea Sacchi (Rome 1599-1661 Rome) St. Gregory and the Miracle of the Corporal 1627, Oil on canvas, 285 x 207 cm. Pinacoteca Vaticana. (Inv. no. 760). Collection of Pinacoteca Vaticana.

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Back to the Basics

The desire to explore is as basic a human need as food. This is surely the reason that explorers often will risk life and limb to discover the answers to questions about our planet and our universe. The feature stories in this issue of *Rotunda* speak as much about the processes and necessity of exploration as they do about what is being investigated.

During his career as a palaeontologist Loris Russell has participated in two exciting periods of dinosaur discovery. The first period, which he calls the golden age of dinosaur hunting, began towards the end of the last century and peaked during the early years of this century. The second period refers to research being conducted in recent years on the actual sites, rather than the fossils, in order to form a clearer understanding of how and where these animals lived. Dr Russell explains how over the past decade he has rediscovered and explored sites in the Edmonton badlands of Alberta, including one site that he first visited sixty-one years ago.

Ed Keall and a team from the ROM have made some rediscoveries in Yemen. It only takes the closure of a country's borders for a generation or two to render a living culture as obscure as any of the most ancient ones in the minds of the outside world. Yemen's architecture and the historical context in which it was built have received only cursory mention in 20th-century literature because Yemen closed its borders towards the end of World War I, and only cautiously reopened them in the early 1970s. As a result, some very important aspects of Middle Eastern history and culture have been neglected. The ROM team's initial research has revealed substantial evidence that Yemen played a far greater role generally in the economic and cultural history of the Middle East than had been thought.

While paleontologists search for evidence of life on our planet that became extinct millions of years ago, and archaeologists learn again about a culture that has been flourishing for over a thousand years, astronomers are launching spacecraft into outer space that over the years report back on the other planets of our solar system. Accumulating facts about our own planet can be a long and often tedious process. Ironically, collecting information on other planets can be an amazingly rapid process. Paul Deans, who was an observer at the Jet Propulsion Laboratory during the Voyager 2 flyby of Uranus, tells us about instant science: the ability of astronomers to instantly analyze data transmitted from our spacecraft.

There is a degree of risk in any exploration but as Nancy Willson points out, this is especially true with regards to manned expeditions to totally unknown regions, be they on our planet or beyond. What many of us may forget is that minimizing the risk is not just dependent upon the sophistication of the navigational and other equipment or the means of transportation; food is of at least equal importance. In fact, many voyages could not have taken place without the development of preserved foods, and others, such as the ill-fated Franklin voyage, failed when spoiled food could not be replaced.

Keeping track of what we learn from exploration is sometimes like a juggling act: while attention is focused on one thing, something else may slip away entirely. And if we gain knowledge about a certain subject while forgetting another, in the end we are no further ahead in our efforts to understand the broad picture of existence, as well as the many details necessary to form this picture. We hope that you make a few discoveries as you explore this issue of *Rotunda*.

S.S.

ROTUNDA
the magazine of the Royal Ontario Museum

Volume 19, Number 2, Fall 1986

Cover: This red-figure *kantharos* from Athens is one of the highlights of the ROM Greek and Roman collection now on display in our recently opened Greek World, Early Italy and the Etruscans, and Bronze and Iron Age Europe galleries. Turn to the story on page 56. Photo by Bill Robertson.

Published quarterly by the Royal Ontario Museum

Printed and bound in Canada

ISSN 0035-8495
Second class mail registration number 1531

Subscriptions and Single Copy Sales
Subscriptions $12.00 (4 issues), outside Canada add $4.00 for postage and handling; single copies $3.50
All circulation and subscription inquiries should be addressed to *Rotunda*, Box 7043, Adelaide Street P.O., Toronto, Ontario M5C 2K7, or telephone (416) 365-1148.

Advertising Sales
Harry J. Allen, Jr for FRESH IDEAS MARKETING INC., 135 Heddington Avenue, Toronto, Ontario M5N 2K9 (416) 484-0060

Editorial and Marketing Offices
Rotunda, Publication Services, Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario M5C 2C6, or telephone (416) 586-5581

General Information, Royal Ontario Museum
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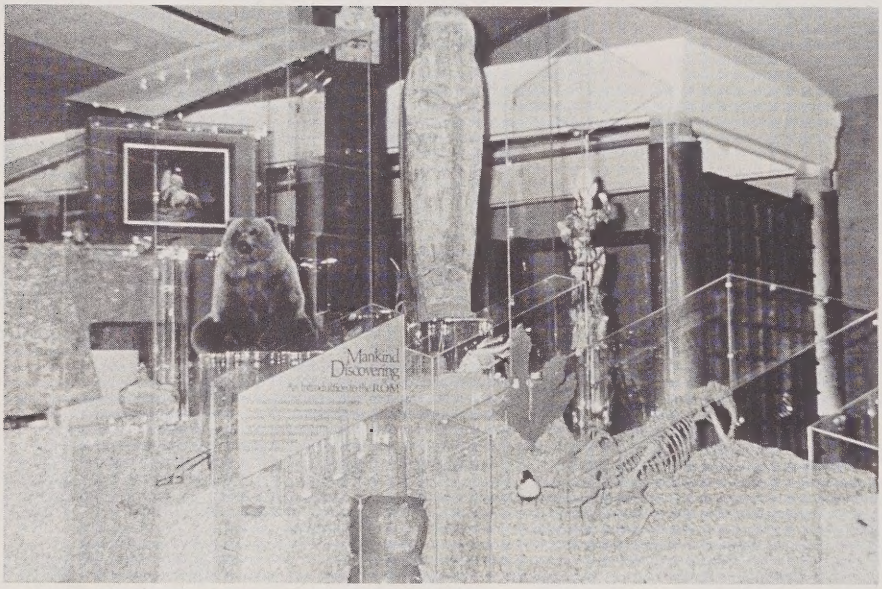
The Modern Museum: Have We Lost the Wonder?

In 1979 the Royal Ontario Museum closed its doors to the public, and embarked on a bold program of renovation and expansion of the entire Museum building and its galleries. The Museum re-opened in 1982, and many of the new permanent galleries are now on view. By the end of this year, a new Far Eastern gallery, Greek and Etruscan galleries, and the Astrocentre of the McLaughlin Planetarium will make their debuts, marking another major step in our long-range goal of completing the entire program by 1991. Since some members of our public and some within the Museum family have rather strong reservations about what they understand to be the philosophy behind the Museum's program of gallery development, I will share some of my own thoughts on this issue.



PHOTOGRAPHY DEPT, ROM

The ROM's *Mankind Discovering* gallery (*top*) shows one kind of exhibit that has replaced traditional displays such as those once found in the invertebrate paleontology gallery (*bottom*).

The presentation of artifacts and specimens in a way that permits the clear understanding of their places within whole cultures or whole environments is the primary goal of a modern museum like the ROM. After spending time at the Museum, visitors should be able to take away a coherent sense of history and culture and of the environment and the structure of nature. Furthermore, they should have some understanding of how we use artifacts and specimens to learn about and to better understand the present and the past of man and nature.

In contrast to these modern goals, I remember a display of Luristan bronzes from western Iran that I organized in the mid-sixties. Some of those bronzes are masterpieces of art and craftsmanship, and I am sure that anyone who stopped to look at that display for any length of time carried away at least an aesthetic experience well worth the viewing. But what did the visitors learn about ancient western Iran? Almost nothing is the answer, unless they took the time to read the long and, I confess, somewhat turgid labels that I had mounted in one corner of the case. (Almost no one took the time; I know because I watched.) This display and a number of other displays of cultural artifacts stood in a small room devoted to ancient Mesopotamia and Iran. Although the material in the display cases was presented in chronological order, there was almost no other effort (on my part) to integrate the displays into a gallery about ancient Mesopotamia and Iran. It was not, in fact, a gallery. It was a *room* in which objects from a certain time and place had been gathered.

The Museum is dedicated to building galleries that can teach as well as delight the visitor. The wonders of nature or the beauty created by human beings will continue to be

the centre of attention in any gallery, but a first-class modern museum display should carry the eye and the mind beyond wonderment and aesthetic enlightenment. While a museum gallery is not suited to teaching a person all they ought to know about such complex subjects as Darwin's theory of evolution, the reptilian fauna of Australia, or the cultural history of Egypt, I am convinced that enough references to such subjects should be in the appropriate galleries to stimulate the visitor to use other media, if he chooses, to learn more. In a sense, I would argue that the Museum is entirely successful when each and every visitor leaves a gallery and heads straight for some other source to find more information about whatever it was that they just saw and experienced. And the visitor should *learn* enough while in the Museum to be able to pursue further knowledge in a sensible way.

With hard work, imagination, constant self-criticism, and on-going debate, we can and will build museum galleries and displays that do much more than my Mesopotamian and Iranian room of twenty years ago. Once a museum display catches a visitor's attention, structured levels of information that make it possible to learn something about the overall subject of the gallery should be available.

In the case of the Luristan bronzes, every visitor who takes the time to look at a display should have the opportunity to learn and understand that those bronzes were but a moment of high aesthetic flourish in a great ancient civilization of the Near East, which had a complex history worthy of more consideration. The visitor will then have the chance not only to carry away his own response to the beauties of human creativity, but also to have some knowledge of the people and the culture behind that beauty. He may also become aware of the special significance of these objects as part of the heritage of other human beings alive and well, and living somewhere else on this small globe spinning through space.

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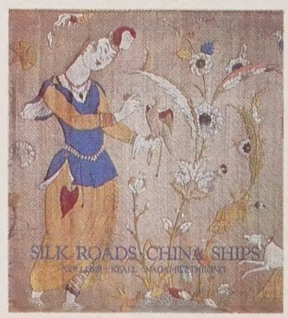

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Now some would argue that this type of gallery display overloads the visitor with information. The result, it is said, is confusion and the loss of the aesthetic experience or a sense of wonder. This simply is not true. We now understand a great deal about the ways in which people view galleries, and how they learn. The visitor can reject the exhibit and just walk on after the briefest glance, or he can stop if anything catches his fancy. If an exhibit grabs his attention, one can build on the visitor's sense of beauty and amazement by presenting information at various levels of complexity, which permits him to explore the galleries in as much detail as he wishes. Eventually some visitors will be able to combine what they have learned in several galleries in order to form opinions and make comparisons of various cultures or natural species.

It must always be the visitor's choice to learn more. In a properly designed gallery it always is. Such galleries do not confuse and overload, rather they provide the opportunity to pursue a subject more fully. You, the visitor, may choose what you care to look at, and the level of information that you want to take away and use.

If you wish to study a subject beyond the limitations of our galleries, may we suggest some possibilities. Take out a membership; you'll automatically receive *Rotunda*. Attend a Museum lecture series about a subject that has caught your fancy. Join the volunteers and work your way into a job in the department of your choice. Call or write the curator in the field that interests you. Buy some relevant books in the Museum shop, contact Publication Services for information about ROM books, or go to your local public library. Take a university or college extension course.

But remember where it all began. The "arts of man" and the "record of nature" were cunningly used to teach you something you never even knew was there to learn, but which you were willing to learn.

T. CUYLER YOUNG, JR

The Good, The Bad, and The Collector

There is a bit of the collector in almost all human beings; restructured and redirected, the collector's instinct is given institutional form through museums. There was a time, and indeed it still exists in a good many institutions, when connoisseurship was the principal basis for museum acquisition, as it is for private purchase. In some fields connoisseurship remains the only kind of expertise that can be brought to bear on questions of authenticity, but in most cases we can now use scientific techniques to provide the answers. Just such an approach has been used with the ROM's large collection of Zapotec funerary urns from southern Mexico, which were acquired early in this century and have been the subject of very considerable debate over the past few decades.

To enter the area of archaeological artifact purchase armed with nothing more than the connoisseur's eye is to risk a quick and unpleasant death on the battlefield. Not only are the products of many ancient societies highly varied and incompletely known from excavation, but in many areas the manufacture of fakes has actually outstripped ancient production, so that, leaving aside all matters of morality and legality, the collector still faces overwhelming odds against acquiring a genuine object. Very early in the history of digging in the Oaxaca Valley the discovery of Zapotec urns engendered a faking industry, which continues to flourish today. Just at the end of World War I, the ROM unknowingly gave support to the industry by its purchase of a collection of supposedly ancient pieces. Although there were a few genuine urns in the lot, the great majority were, despite their appearance of antiquity, just a few years old.

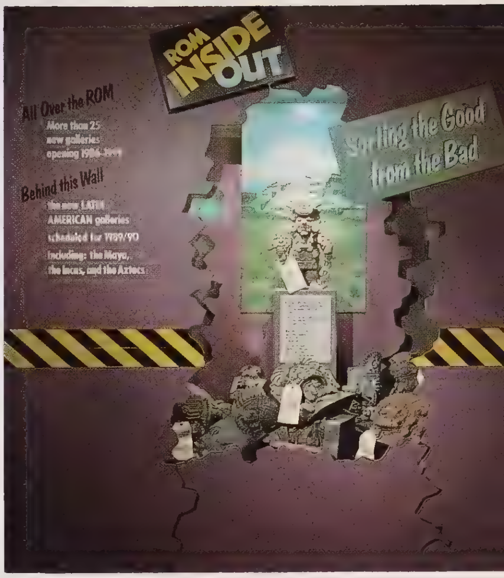
In the days when the urns were purchased, very little was known about Zapotec gods and their images, and hence connoisseurship was on even shakier ground here than usual. In later years, increasing knowledge of Zapotec iconography led some scholars to question the authenticity of many of the urns because of incorrect combinations of face and costume, or use of the wrong identifying glyph with a deity. Still, some clung to the belief that most of the objects were ancient, perhaps with the same tenacity that marks a private collector's unwillingness to acknowledge that he has been gulled by dealer or faker. Now we can show, thanks to thermoluminescence testing, that both the suspect pieces and some that were thought to have a reasonable chance of being genuine were in fact made early in this century. Though the figures long formed part of the old Mexican gallery displays, they will not make an appearance in the new Latin American galleries, except perhaps to reinforce the words that should ring loudly in every collector's ears: *caveat emptor.*

Today the ROM does not stand in danger of being hoodwinked in another Zapotec caper or any other attempt to pass off Mesoamerican fakes as genuine, because our acquisition of archaeological material comes about only through controlled excavation. For the collector who refuses to recognize the antiquities laws of Mesoamerican countries and the laws of Canada that make importation of looted material illegal, the danger of being hoodwinked is huge, and no one concerned with the preservation of our human heritage will weep over the consequences of a fool rushing in where scholars will not tread. Instead of weeping, what we have done, in the process of developing our new Latin American galleries and cleaning our own house, is to put the history of the Zapotec urn collection on view. That history tells the viewer something about the processes that underlie gallery development, but it also serves as a lesson to those whose confidence in their connoisseur's eye is as misplaced as was that of the ROM some seventy years ago.

The Zapotec urn collection is on view in one of the new *ROM Inside Out* displays, which focus on aspects of the Museum that the visitor does not normally see. A number of fakes are shown next to a genuine Zapotec urn with the inaccuracies of the fakes highlighted. It is immediately apparent how deceptive the fakes are to the untutored eye.

In a tradition started by the ROM's introductory theme gallery, *Mankind Discovering*, which explains the process of scientific research, *ROM Inside Out* introduces the museum visitor to some of the processes of gallery development. Other *ROM Inside Out* displays cover such topics as conservation work, taxidermy, modelmaking, diorama making, and gallery design. Displays will have been developed by the end of 1986, located throughout the Museum in walls blocking off the construction sites of new galleries. Once construction begins, visitors will be able to watch each new gallery take shape through viewing portholes.

DAVID PENDERGAST
CATHERINE FARLEY



COURTESY EXHIBITION DESIGN SERVICES, ROM

Sorting the good from the bad is the theme of this ROM *Inside Out* exhibit of urns. One genuine Zapotec urn is displayed above the rest, which are fakes. Such displays help visitors to the ROM better understand the behind-the-scene functions of the Museum.

What Mackenzie and Others Failed to See

Of the uses of simples and plants they have no knowledge; nor can it be expected, as their country does not produce them.

Alexander Mackenzie

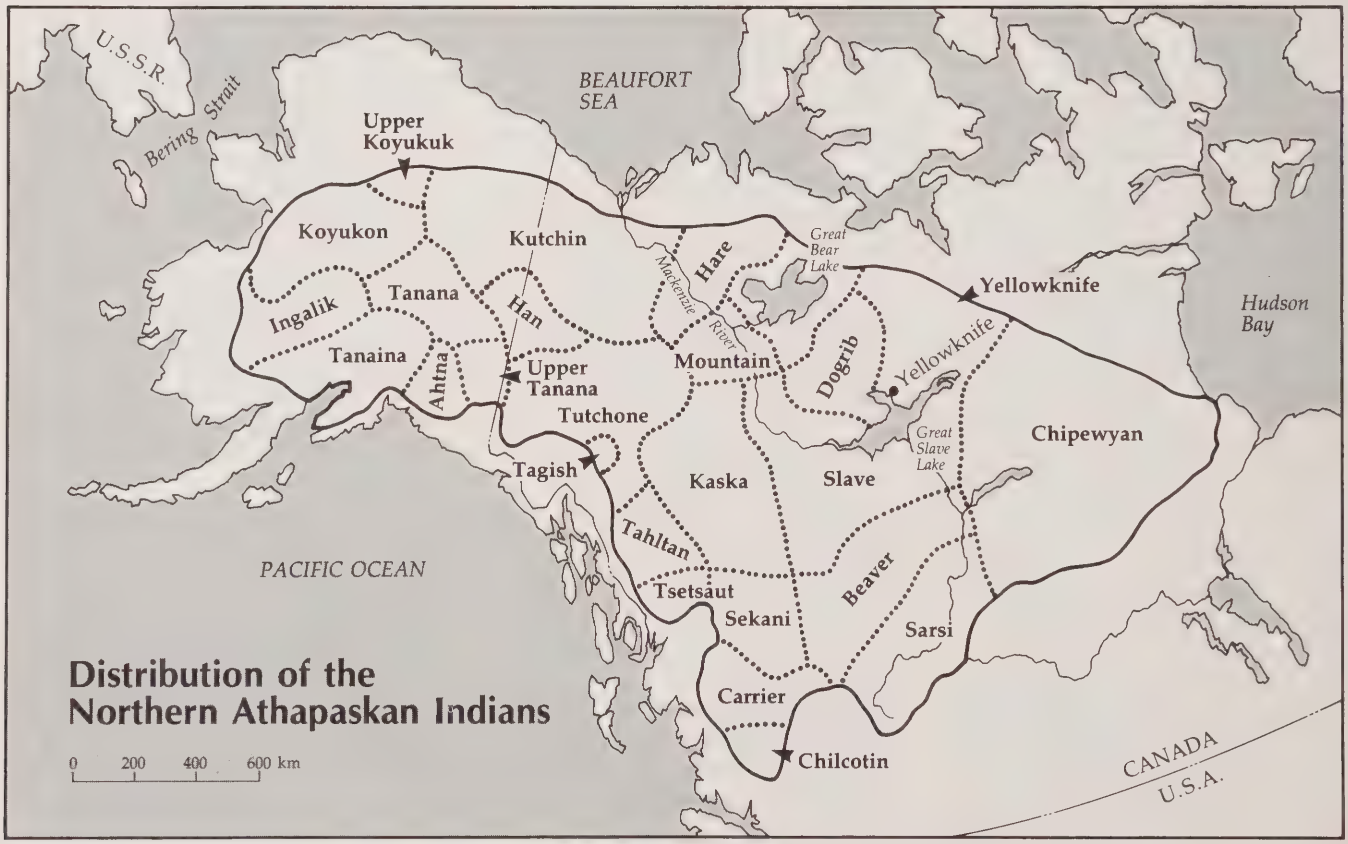
Writing about the Chipewyan, Alexander Mackenzie made the mistake of many other Europeans whose journeys took them through the lands of the northern Athapaskan peoples, who lived in what is now northern Canada. He assumed that northern plants that could serve as sources of food and medicine were meagre or non-existent, and that in any case the Indians could offer him little information about them.

Mackenzie had travelled through the southern lands of the Cree before beginning his journeys northward in 1789 and 1793. After the great variety of fauna he found in the south, the northern landscape must have seemed particularly barren. And the Cree, unlike the Athapaskans, were already known for their extensive use of medicinal and food plants.

The vast northlands were not completely uncharted by the time of Mackenzie's first journey. Twenty years earlier, Samuel Hearne had been one of the first outsiders to enter the area. Mackenzie first travelled through northern Athapaskan country in 1789, and his descent of the river that now bears his name opened up the north to the fur trade. In later years, Sir John Franklin's journeys of 1819 and 1825 and Sir John Richardson's account of 1849 produced further documentation of the area. By 1860, the first missions were established on the lower Mackenzie River and the missionaries' accounts became another source of information; the writings of Émile Petitot were particularly respectful of the native people whom he met between 1862 and 1883. Adventurers, gold seekers, scientists, and many others continued to add to the documentation of the north and its people.

Nevertheless, for the most part, northern Athapaskan Indians have not been credited in the historical literature with an extensive knowledge and use of wild plants for food and medicine. However, their reliance on hunting, fishing, and, later, trapping for sustenance received extensive coverage in the writings of European recorders of northern history. The obvious technological uses of plants for canoes, baskets, nets, and such received far greater acknowledgement and documentation than nutritional and medicinal uses.

There are several possible explanations for this serious oversight of an important aspect of Athapaskan culture. Most of the early explorers and other visitors to the north were there for purposes other than to comprehensively document the native way of life. What those visitors chose to record was a reflection of their own attitudes, backgrounds, and interests as they concerned anything from the extension of the empire and the economic exploitation of the north, to the saving of souls and the struggle to survive. Through their writings the Europeans tell us as much about them-



Distribution of the Northern Athapaskan Indians

selves as they do about the native people of the area. Since plant gathering apparently did not capture the European imagination in the same way as did hunting and other more spectacular activities, it was not frequently recorded. That gathering plants for food and medicine was primarily a women's activity may have been another reason for its being treated in a cursory manner by male observers.

Information about plants used for native medicines was particularly sparse. Because Christian churches associated native medicine with native religion, the use of wild plants for medicinal purposes didn't meet with their approval. Thus shamanistic medicine would not have been disclosed readily to the whites. There

LES GRANDS ESQUIMAUX BY EMILE PETITOT, 1887

". . . they are fond of the young roots of the "maso" (Hedysarum alpinum), a species of wild licorice; the other favorite are roots of the yellow pond-lily, the pith of the flowering rush, the tart stems of the cow parsnip and wild rhubarb (Polygonum elliptica)."
"If the Indian runs out of food altogether . . . he will go out and scrape rocks, gathering a black cockled lichen of the genus Gyropora; this cryptogam, when boiled, will provide a smooth and nourishing gelatine (*the-tsin*, or rock tripe) to feed the children."

writings of Emile Petitot

were, of course, notable exceptions. Helge Ingstad, a Norwegian adventurer who spent four years in the Barrenlands, wrote in 1933: "From an old Indian I once received the information that he knew about thirty different kinds of medicines, amongst these a poison which could kill a human being in the course of five minutes. Further than this he would say nothing, for an Indian guards his medical knowledge with the most scrupulous secrecy." *Dene Surgery* by Father A. G. Morice, the writings of Émile Petitot and Andrew Graham, and even a survey of the general historical literature suggest that what was known about plants was more extensive than was usually acknowledged, and in fact, this knowledge played an important part in the lives of the northern Athapaskans.

Edible berries were among the most readily available and commonly used plants in Athapaskan country. Cranberries, blueberries, crowberries, saskatoons, cloudberries, soapberries, raspberries, strawberries, currants, gooseberries, and high-bush cranberries were all there for the picking. Bearberry was eaten, and its leaves were used as a tobacco substitute or additive.

Medicinal teas were made out of wild mint and Labrador tea; spruce tea was well known as a cure for scurvy. Spruce gum was cited often, among other things, as a cure for snowblindness. Before the gum was applied to the eyeball or eyelid, a layer of grease was applied to prevent the gum from gluing the eye shut.

Willow seemed to be an all-purpose cure for a variety of ailments. In fact, willow *(Salix)* contains a bitter-tasting substance called salicin, which is a compound of salicylic acid. When a sore or wound worsened, a blister composed in part of the inner bark of the willow *(Salix longifolia)* was applied. And willow leaves chewed to a paste were applied to wounds and insect bites for relief. The synthetic compound aspirin contains the same effective ingredient.

Wild onion, dog tooth, cow-parsnip and willow-herb were just a

JOHN NIEDERKORN

MARILYN WALKER

H. JONES, COLLECTION OF ARCHIVES OF THE NORTHWEST TERRITORIES

Above: Charlotte Jones tapping birch tree for syrup. Birch had other uses too. The fungus that grows on birch trees was used as a tobacco substitute or made into a tea. The buds were also used as a medicinal tea, and the pulp was eaten as an emergency food source.

Top left: White and black spruce, jack pine, birch, and poplar are typical of the Boreal Forest landscape, the traditional homeland of the northern Athapaskans. *Bottom left:* In the transitional zone situated between the Boreal Forest and the treeless tundra, the density of trees gradually decreases, as does the overall size of the trees. Northern Athapaskans that lived near the transitional zone exploited it seasonally.

few of the wild plants that are known to have been consumed by the northern Athapaskan. Though the plants may never have been a major part of the diet, they were an important food source when meats and fish were scarce. They also provided a welcome variety to the regular diet.

Community studies conducted during the last ten years among the inheritors of northern Athapaskan oral history further confirm the extensive use of wild plants for food and medicinal purposes. Yet there is still an important reason why many early explorers in the north may have ignored an essential part of Indian culture that they more readily acknowledged in the Indian culture of the familiar southern territories. Looking again at the exploits of Alexander Mackenzie, in an 1801 journal entry we find the statement:

> I do not possess the science of the naturalist; and even if the qualifications of that character had been attained by me, its curious spirit would not have been gratified. I could not stop to dig into the earth, over whose surface I was compelled to pass with rapid steps; nor could I turn aside to collect the plants which nature might have scattered on the way, when my thoughts were anxiously employed in making provision for the day that was passing over me. I had to encounter perils by land and perils by water . . . I had, also, the passions and fears of others to control and subdue. To-day, I had to assuage the rising discontents, and on the morrow, to cheer the fainting spirits of the people who accompanied me.

Had Mackenzie found the time to learn more about the science of the naturalist, especially the local native variety, perhaps many of his dilemmas could have been averted.

MARILYN WALKER

Plant Alert What to Watch for in the Summer and Fall

The greatest number of poison control calls are received by the ROM Botany Department in the summer and fall, the seasons when numerous fruits, berries, and mushrooms reach their peak. Many of the inquiries are about plants that are not poisonous. Furthermore, it should be emphasized that the ingestion of large quantities of most toxins from poisonous plants is necessary to seriously harm a person. Mushrooms are the important exception; many mushrooms are deadly. Wild mushrooms are difficult to identify; therefore it is best not to eat any mushrooms picked by someone other than an expert.

Berries pose a problem for identification if they are not collected together with the stem and foliage. On their own, berries from many different plants look alike and often ripen at the same time. To identify berries, one should note their colour, their grouping (singly or in clusters, and the cluster shape), the type and number of seeds, and the shape and arrangement of the plant's leaves.

Inquiries are frequently received about several non-poisonous plants. The mulberry tree *(Morus alba)* is most often described as the raspberry tree because its fruit looks like a large oval raspberry. The leaves have saw-toothed edges, which may be irregularly lobed. The fruit is borne in the leaf axils. Tartarian honeysuckle *(Lonicera tatarica)* is a shrub or vine commonly found in hedges and fields. Its leaves are positioned opposite one another, and its berries are red, orange, or yellow, many seeded, often joined together at the base, and borne in pairs in the leaf axils. Highbush cranberry *(Viburnum opulus)* is abundant in garden hedges and in the wild. Its leaves are positioned opposite one another, are three-lobed (similar to maple leaves), and are attached to the branch by a long stem called the petiole. Its red berries grow in flat-topped clusters. Mountain ash *(Sorbus americana)* grows in woodlands and as an ornamental plant in gardens. It has pinnately compound leaves (leaves that are divided into many pointed leaflets like a fern) with serrated edges on the leaflets. Its berries are orange and grow in flat-topped clusters. The fruits of all of these plants are edible when ripe.

Red Mulberry

HOW TO KNOW WILD FRUITS, DOVER PUBLICATIONS

Tartarian Honeysuckle

Mountain Ash

SHRUBS OF ONTARIO, ROM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Here are the poisonous plants to be aware of in the summer and fall.

Foxglove *(Digitalis purpurea):* This is a common garden plant that blooms in the summer. It has tall racemes with downward-pointing bell-shaped flowers. The flowers may be purple, rose, pink, yellow, or white; all have spots on the inside. The stems are downy, and the leaves are slightly serrate and positioned alternately along the stem. All parts of the plant are poisonous. The toxin, digitalis, is prescribed in controlled doses by physicians to treat heart disease. When ingested in excess quantities, it causes its victims vomiting, severe headaches, irregular pulse and heartbeat, convulsions, and death.

Bittersweet or Deadly Nightshade *(Solanum dulcamara):* This is a common vine that is found in woods, fields, fence rows, and entwined on shrubs and trees that are commonly found in gardens. The plant produces a small purple star-shaped flower with a protruding yellow centre. Its berries first appear in June and July, and persist with the flowers until mid-October. The berries are borne in elongate clusters, and at maturity they usually range in colour from green to orangey-red. The leaves are distinctly spade-shaped, often appearing pinched-in at the base with two small lobes extending to the sides like wings. The berries have many tiny white seeds, and when they are squeezed they smell like tomatoes or rotten meat. This plant is a member of the tomato family, and like other members of this family it contains the toxin solanine, a glyco-alkaloid. The ingestion of large quantities of solanine causes extreme stomach upset and nervous and respiratory disorders to its victims. We receive more poison-control calls about this plant than any other.

Poison ivy *(Rhus radicans):* Poison ivy may grow as a shrub, or as a vine sprawling on the ground or climbing trees and shrubs. It can be identified by its three leaflets, each of which is smooth edged and may be slightly


SHRUBS OF ONTARIO, ROM

Poison Ivy

lobed. The leaves vary in colour, tending to be green and shiny in early spring, sometimes turning to a shade of red in late summer and fall. The plant may produce fruit that is white to light yellow in colour, and grows in an elongate grape-like cluster, often pressed closely to the stem. *All parts of the plant are toxic.* Poison ivy is one of the most common skin irritants. The sap, which is found in all parts of the plant, causes a rash that forms itchy blisters and lesions. The sap is released from bruised parts of the plant and may be transmitted by animals, clothing, tools, and even ashes in the smoke from burning plants. Poison ivy causes an allergic reaction in those that are sensitized to it; the reaction occurs immediately upon contact of the sap with the skin. Sensitivity to poison ivy increases with exposure.

Yew Bush *(Taxus):* This evergreen bush is commonly planted in hedge rows and gardens; it also grows in woods or fields. The bush has flat needles that grow in one plane. It bears red, fleshy, fruit-like structures (arils) that surround a green or black seed. Each aril looks somewhat like a red olive stuffed with a seed rather than a pimento. The aril is not poisonous but the seeds, leaves, and bark can be deadly if chewed. The toxin is taxine. When ingested, it causes its victims diarrhea, trembling, pupil dilation, and difficult breathing.

Milkweed *(Ascleoias):* Milkweed is a tall herb commonly found in old fields and marshes. The leaves are downy and positioned alternately


F. REDELMEIER
Foxglove


M. FERGUSON
Black Cherry


D. METSGER
Above: Bittersweet or Deadly Nightshade *Below:* Yew Bush


COURTESY BOTANY DEPT, ROM

along the stem. A milky sap is found throughout the leaves, stems, and pods. The flowers are pink, flat-topped corymbs. The fruit is borne as erect pods filled with many seeds. Each seed has a plume of fine silky hairs that acts as a parachute when the seeds are dispersed by wind in the late fall. The milky sap is composed of latex, which contains a cardioglycoside toxin. Ingestion of this toxin causes vomiting, depression, weakness, loss of coordination, and respiratory paralysis in its victims.

Horse-chestnut *(Aesculus hippocastanum):* This is a tree or shrub. It has palmately compound leaves (divided into spreading segments like a hand) on long leaf stalks. The leaflets are toothed along the edges. The yellow, red, or white cone-shaped flowers appear with the leaves in May. In late August the tree produces spiny green husks that surround several shiny brown nuts, each with a purple scar. The leaves, flowers, young sprouts, and entire seeds contain the glycoside esculine. If this toxin is ingested it causes nervous twitching, lack of coordination, dilated pupils, vomiting, diarrhea, and paralysis in its victims.

Black cherry *(Prunus serotina):* This is a wild cherry tree. It has shiny leaves that are lighter in colour on the back, with slightly rounded teeth on their edges. The mid-rib of each leaf is lined on the back by fine white or rusty hairs that are found from the base to the middle of the leaf. The leaves are positioned alternately along the stem.

The fruit is borne in long drooping racemes (pin cherries grow singly). Most members of this genus contain differing quantities of the cyanogenic glycoside amygdaline, in some or all of their parts. In this species there are large quantities of toxin in the seeds, leaves, and bark. The fleshy fruit is edible; the pit, which is where the seeds are found, is not. If the toxin is ingested it causes breathing difficulties, spasms, and coma in its victims. It can be deadly if eaten in large quantity.

DEBORAH METSGER

EXPLORING A GREAT DINOSAUR GRAVEYARD

Loris Russell, the last survivor of the golden age of dinosaur hunting, has found new information in old sites.

Loris S. Russell

ONE of the world's richest sources of dinosaur fossils is the valley of the Red Deer River in Alberta. Since 1884, when geologists and palaeontologists began to discover and to collect the bones of these remarkable prehistoric reptiles, more than sixty-five different kinds of Alberta dinosaurs have been described in the scientific literature. Many of them are displayed in the world's great museums from London to Buenos Aires. These fossils reveal what dinosaurs looked like as living animals, how they moved and fed, and how they were related to each other anatomically.

Scientists would also like to know more about the environment in which dinosaurs lived, at what times in geological history they were abundant, and under what conditions individuals and the entire genus died and were buried as part of the geological record. In particular they would like to know why, with seeming suddenness, all dinosaurs disappeared, leaving the earth free for the great mammalian take-over. To answer these questions scientists must look to the geological evidence found at the sites of the fossil skeletons.

The fossil-bearing rocks of the Red Deer River valley are exposed in areas known as badlands where erosion has created a labyrinth of hills and ravines or, to use the western terminology, buttes and coulees. The badlands have developed in two areas. One is situated northeast of Brooks, and today is incorporated in Dinosaur Provincial Park; it was long known as the Steveville badlands, after a village that no longer exists. The rocks exposed here are part of the Oldman Formation, and date from about seventy million years ago. The other badlands area of the Red Deer River valley begins about ninety-five kilometres upstream at the city of Drumheller, and extends another fifty kilometres northward. As the rocks exposed here are part of the Edmonton Group of formations, the area is known as the Edmonton badlands, although it is one hundred and

COURTESY L. RUSSELL

M. STEFANUK

Above: In 1923 Jim Thurston (*left*) and Loris Russell (*right*) apply plaster to the underside of a limb of an *Edmontosaurus*, discovered by C.M. Sternberg.
Left: Sixty-one years later, Loris Russell returns to the same site to conduct new research.

sixty kilometres or more from the city of that name. Between the two badlands areas the river valley exposes small outcrops of shale with fossil marine molluscs. A record of three major geological events appears in this region: first, the development of a large coastal plain with abundant vegetation and a multitude of land animals; second, in the area between the two badlands the invasion of the sea from the southeast, driving the terrestrial life westward; finally, the withdrawal of the sea, allowing the re-establishment of conditions suitable for land animals and plants.

The rock layers of the Edmonton badlands include valuable coal seams, and for this reason they have been the subject of detailed geological study for many years. The sequence of the various strata, including the coal seams and other marker beds, has been determined and mapped. Such studies make up the science of stratigraphy. Because of the well-established rock sequence of the Edmonton badlands and the abundance of dinosaur fossils, this seemed an ideal area in which to study the combination of the physical and the biological records, that is, the biostratigraphy. In this region, which I call the last great dinosaur graveyard, such a project appeared especially worthwhile because there was a possibility that it would reveal the record of events in the closing stages of dinosaurian history and perhaps some explanation of the mystery of their extinction.

A start already had been made between 1910 and 1912 by Barnum Brown of the American Museum of Natural History when he collected a number of dinosaur fossils from the Edmonton badlands. Later Charles M. Sternberg, the famous collector for the Geological Survey of Canada, made and recorded important observations on the geological occurrence of his own discoveries. However, there seemed to be an opportunity to produce a more precise and comprehensive compilation, and as the last survivor of the "golden age" of dinosaur hunting I felt an obligation to try.

Establishing a Geological Sequence

M. STEFANUK

Using a method of hand-levelling, Loris Russell determines the vertical height between the original level of the fossil remains of the *Edmontosaurus edmontoni,* found by Charles Sternberg, in 1912, at Michichi Creek, and the nearest marker bed.

As each site is located it has to be placed in the known geological sequence. Before this can be accomplished, published descriptions are read, and observations of other sites in the area are made, in order to determine the identification of the local stratigraphic markers such as coal seams, volcanic ash layers, or fossil shell beds. Next, the vertical height between the original level of the fossil and the nearest marker bed is determined by some form of instrumental surveying. The simplest method is hand-levelling.

With this method an instrument is used that combines a spirit-level with a pair of sights. The operator lines up the sights with some target, such as the marker bed, then shifts his position until his line of sight is horizontal, as indicated by the spirit-level. The target object then may be assumed to have the same elevation as the observer's eye. Next he moves to stand at the target, and he repeats the horizontal sighting on a higher conspicuous object, thereby measuring a

I had known all the famous collectors, had visited many of their discovery sites, and had worked for some weeks under Charles M. Sternberg at the taking up of a dinosaur skeleton. Thirteen years with the Geological Survey of Canada had also taught me how to compile stratigraphic sections including the fossil record. Thus my new data could be integrated effectively with the stratigraphic records already established by geologists of the Geological Survey of Canada and the Alberta Research Council.

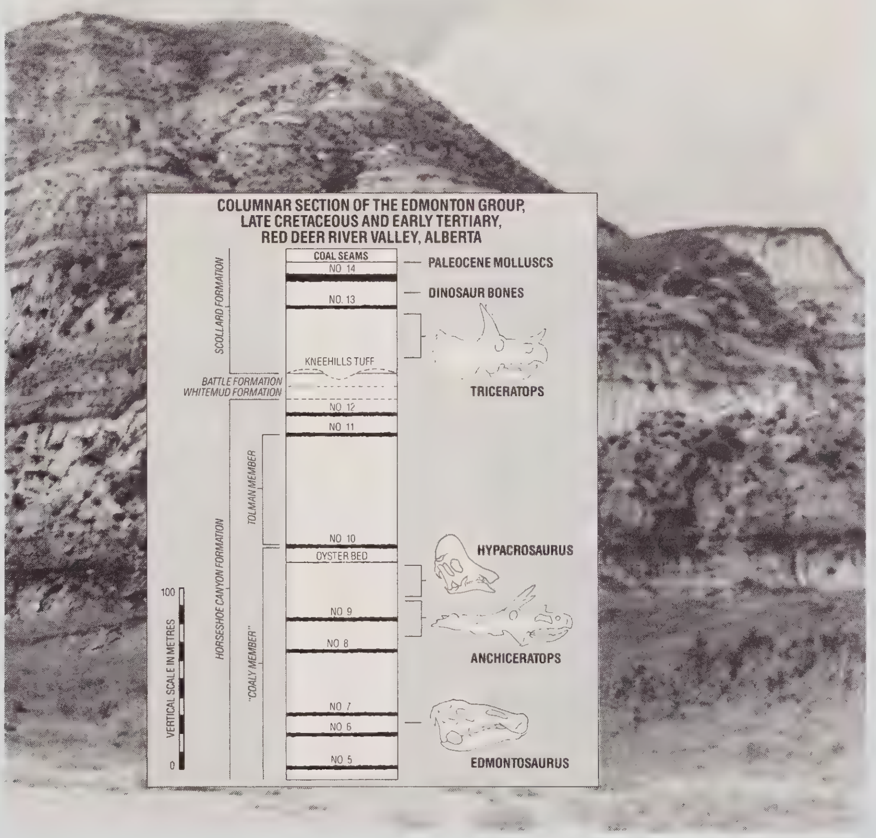
Grants from the National Research Council of Canada and the Natural Sciences and Engineering Council of Canada provided the necessary financial support, and the facilities of the Department of Vertebrate Palaeontology of the Royal Ontario Museum provided the technical support. So I set off in 1977, accompanied by Mrs Russell, to explore the geological record exposed in the Edmonton badlands between the cities of Red Deer and Drumheller.

The first step was to locate the sites where the skeletons had been entombed. Some of these sites were easy to find. Either I had been there when the skeletons were taken up, or I had visited the scene with the collectors soon afterwards. When first-hand information was unavailable I consulted the field notes and photographs made by the collectors while the specimens were being removed. Such documentation compiled by Charles Sternberg and his two brothers was kindly provided by the National Museum of Natural Sciences and the Royal Ontario Museum. (Interviews with "old-timer" residents provided clues to place names no longer in use.) In addition, published descriptions of the specimens in scientific or popular journals usually include a sentence or two on the location, perhaps accompanied by the land-survey coordinates. Being from Kansas, the Sternbergs understood the Canadian land-survey system, for it was modelled on the system used in the western United States.

In the last two years of my search for the discovery sites I have been fortunate to have the collaboration of Mr Maurice Stefanuk of Drumheller, an enthusiastic

vertical height equal to the height of his eye above ground. In my own case this height is 1.6 metres; therefore I could measure up a hillside between marker bed and fossil site in intervals of height of 1.6 metres.

A refinement of this technique is to use a rod marked off in intervals of feet or metres. This is known irreverently as a jake stick, after Jacob's staff. It permits measuring in more detailed intervals. When it is necessary to carry the survey some distance laterally, a precision barometer (altimeter) may be used, or even a stadia-compass survey. I have used all of these methods to establish the position of the dinosaur sites in the stratigraphic sequence. The bridges over the Red Deer River have served as benchmarks, as the Alberta Highways Department has established their topographic elevations. Even the water-level of the river can be a reference datum if one allows for average stream fall and seasonal variation.

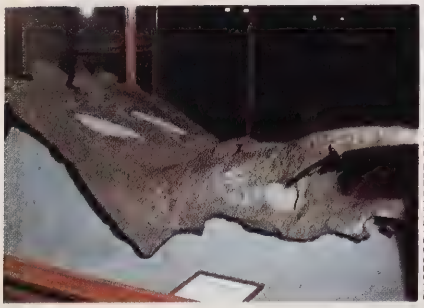


The Edmonton badlands north of Munson Ferry, Alberta.


COURTESY L. RUSSELL

Top: Skeleton of *Anatosaurus edmontoni* in the collection of the National Museum of Natural Sciences.
Bottom: Skull of *Anchiceratops ornatus* in the collection of the ROM.


NATIONAL MUSEUMS OF CANADA


PHOTOGRAPHY DEPT, ROM

fossil hunter who had independently recognized the importance of finding these fossil sites and recording their location. He had already located a number of them by the time that we joined forces.

One site that I especially hoped to find was of historic as well as of scientific significance. In 1912, the first year that the Sternberg family worked in Alberta, Mr C.H. Sternberg, the father, found and collected a surprisingly good skeleton of a duck-billed dinosaur. This was the first major find by a Canadian expedition. Although it has had a variety of names, this dinosaur is now generally known as *Edmontosaurus edmontoni*. Mounted in a wall panel, its bones in approximately the same position as when they were found in the rock, this specimen has been on display for many years in the National Museum of Natural Sciences in Ottawa (formerly the National Museum of Canada). It is a typical duck-billed dinosaur, with a long sloping skull and an expanded snout like the beak of a duck.

Sternberg, in his field notes, recorded the skeleton as coming from the valley of Michichi Creek, about six miles north of Drumheller, and forty yards above the forks. Michichi Creek enters the Red Deer River at Drumheller, but our traverses on foot and by four-wheel-drive vehicle failed to establish which tributary formed the forks. Maurice Stefanuk solved the problem by consulting the local farmers. Sure enough, Mr John Caswell knew the site very well; it was on his land, and his father had helped the Sternbergs with the excavation. He obligingly guided us a mile south through his field to the valley edge, and from there it was an easy climb down to creek level.

There it was. An unmistakable quarry created a conspicuous notch in the valley wall about fifteen metres above the flat. We took numerous photographs, and using a hand level and rod we determined that the floor of the quarry—hence the approximate original level of the skeleton—was six metres above the nearby No. 7 coal seam. We came away pleased and thrilled to have located the site.

The day was still young, and Maurice wanted me to see another site. This one was designated by a brass marker bearing the name of the National Museum of Canada. We drove north and west to Bleriot Ferry, where we crossed to the west side of the valley. (Back in the 1920s, Bleriot Ferry had been operated by

the brother of Louis Bleriot, the first man to fly the English Channel in an aeroplane.) A drive of a few miles north and then east along the township line brought us to the edge of the Red Deer River valley, overlooking a large area of badlands. I followed Maurice down the slope and out along a ridge past the rich bed of fossil oyster shells that extends for miles along the valley. Down another slope into a ravine—and there we were.

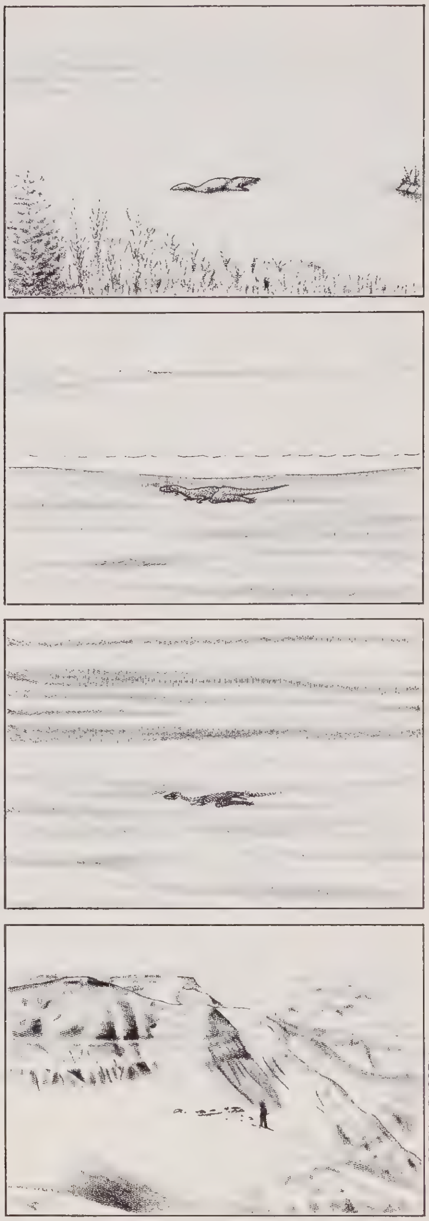
After sixty-one years I had returned, for in 1923 this was the quarry where my boyhood friend Jim Thurston and I helped C.M. Sternberg take up a fine skeleton of another *Edmontosaurus*. This skeleton had complete limbs and tail but unfortunately lacked the skull, which had been washed away by the erosion of a small ravine. (The skeleton is now one of the exhibits in the British Museum in London.) In the past I had always approached this site from the river flat, continuing up through the coulee. I was there in 1956 when Dr Wann Langston set in the National Museum of Canada marker number 124. But I was glad to have learned of another way in and to find a path where I could measure easily the interval from the dinosaur site up to the oyster bed. One could say that we had put one more dinosaur in its place.

Not all of the important discoveries were made by experienced collectors. I mentioned my boyhood friend Jim Thurston. In 1922 he was a volunteer with the Royal Ontario Museum expedition under the direction of Levi Sternberg, the youngest of the three brothers. They were camped near Stauffer Ferry (now Morrin Bridge), and Jim was enjoying a summer of learning and congenial companionship. As I was stuck in Calgary with a summer job, I read his frequent letters with interest and a touch of envy, especially when one arrived with the ecstatic announcement: "I found a dinosaur."

It was the skull of a horned dinosaur, *Anchiceratops ornatus,* which, like its better known relative *Triceratops,* had a short horn over the nose, a longer one over each eye, and a bony crest extending back from the rear of the skull. *Anchiceratops* was smaller, its horns were shorter, and its crest had two large openings for muscle expansion. This skull was on display for years in the dinosaur gallery of the Royal Ontario Museum, but is is now in live storage, where it can be inspected by anyone who is interested. In 1928 Jim showed me the site of his find. It is on the east side of the river valley, about one kilometre north of the Morrin Bridge, and facing what is now the municipal baseball park and campground. The skull was lying partly exposed on a low promontory, about nine metres above the valley flat and four and one half metres above the No. 8 coal seam. On a high butte located on the opposite side of the river across from the campground, one can see the quarry from which George Sternberg collected a fine skeleton of the dinosaur *Edmontosaurus* in 1916 for the National Museum of Canada.

One of the last of the great flesh-eating dinosaurs or carnosaurs was discovered by C.M. Sternberg in 1946, east of the appropriately named village of Huxley. At the suggestion of Dr Dale Russell of the National Museum of Natural Sciences, my wife and I called on Mr Kent Knudson, the owner of the farm where the discovery site was located. He took us to the edge of a large valley located west of the farm buildings, and pointed out a reddish object on the flat below the cliff. After a scramble down the cliff face to reach the object, an inspection showed that it was a shattered ironstone concretion containing bone fragments, apparently from a broken skull. Halfway up the cliff large limb bones were still in the rock. I returned to this site several times, and determined by instrument surveys that the bones were thirty-four metres above the base of the Scollard Formation and nine metres below the No. 13 (Nevis) coal seam, which some palaeontologists regard as the marker for the Cretaceous-Tertiary boundary, that is, the transition from the age of dinosaurs to the age of mammals.

Charles Sternberg decided that this specimen was not good enough to justify the work of collecting it from a site so difficult to reach. Those that followed him, including myself, agreed. But in 1982 the newly established Tyrrell Museum of Palaeontology in Drumheller sent a crew to the Knudson farm where they partially exposed the bones, and prepared sections of rock with the bones still encased for handling. The problem of getting the rock sections to the


DRAWINGS BY L. RUSSELL

In the top drawing, the carcass of a *Gorgosaurus* is partly buried in the mud. Next, the whole carcass is buried in accumulating sediments. Over time, the skeleton of the *Gorgosaurus* becomes encased in sedimentary rock. Millions of years later, the skeleton is exposed by erosion, and it is discovered.

COURTESY L. RUSSELL

Loris Russell is standing at C.M. Sternberg's site on Knudson's Farm. Because it was so difficult to reach this site, no one tried to remove the fossil remains from this location until a crew from the Tyrrell Museum found a way in 1982.

top of the steep cliff was solved by bringing in a large crane that hoisted them to the field above, where they were loaded into a truck and taken to the Tyrrell Museum. I have heard from Dr Philip Currie of that institution that the skeleton is turning out to be better than expected, and that it represents a large individual of *Dynamosaurus,* a relative of *Tyrannosaurus.*

These are four of the fifteen dinosaur graves that I have located geographically and stratigraphically, working either independently or in collaboration with Maurice Stefanuk. With the compilation of the geological data some patterns have emerged. As is well known to geologists, about seventy million years ago the western interior of North America was occupied in part by an inland sea. At one time this sea extended from the Gulf of Mexico to the Arctic Ocean, but when the geological and biological records of the Edmonton badlands begin, marine waters were starting to withdraw from what is now central Alberta, leaving behind extensive swamps where organic matter accumulated as the raw material for future coal seams. The rock layers deposited at this time contain few dinosaur fossils. Does this mean that the dinosaurs were slow to move into the newly drained areas, or that the conditions were not suitable for the preservation of their bones? The former explanation seems more likely, as the sediments in question appear to indicate an environment similar to that of later times when dinosaurs left abundant remains.

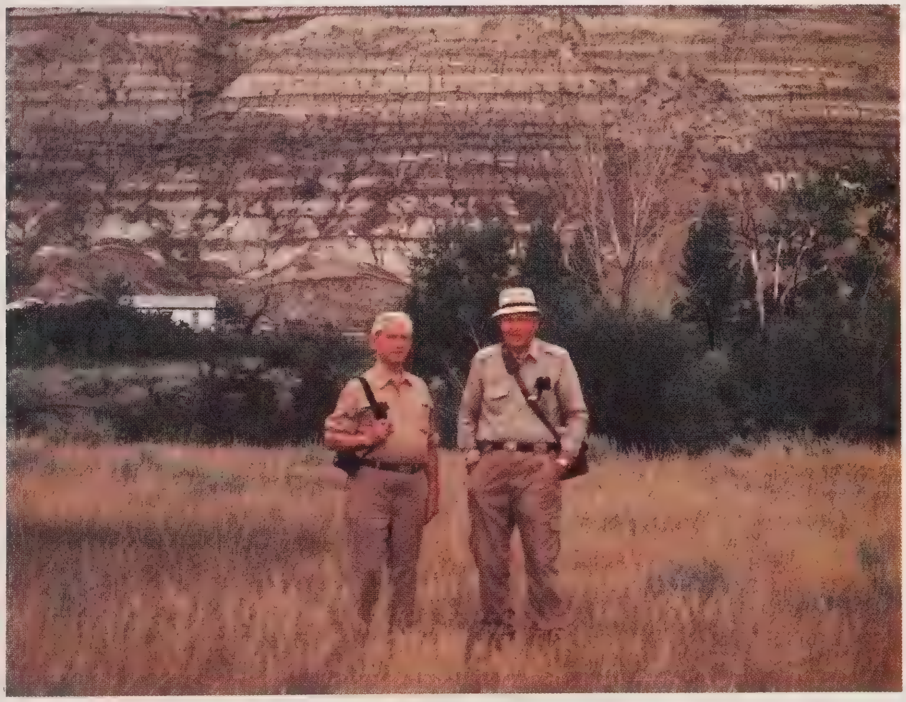
The first dinosaurs to re-invade the coastal plain were the duck-billed dinosaurs or hadrosaurs, which include *Edmontosaurus.* These were the real duck-billed dinosaurs, with long, sloping skulls and flat, expanded snouts protected

by a horny beak. Batteries of teeth, fitting together to form a grinding apparatus suitable for crushing and shearing coarse vegetation, were located farther back in the jaws. Webbing between the toes, and tails flattened from side to side, suggest that these animals spent much of their time wading or swimming in search of food or safety. Well-preserved "flat-heads" have been found from Drumheller to about five kilometres north of Bleriot Ferry. Other kinds of dinosaurs are present here, including the predaceous *Albertosaurus* and the slender bird-mimic *Ornithomimus*. These occurrences seem to represent the last time that dinosaurs were really abundant. Although sand and clay accumulated to a thickness of about ninety metres, deposition must have been slow, for there are no associated gravel beds, and numerous coal seams indicate times of widespread swamp conditions.

A brief return of the sea is also recorded in the strata. True marine conditions reached no farther west than what is now southwestern Saskatchewan, and bodies of brackish water spread inland as estuaries, deltas, and coastal swamps. As a result, great beds of oyster shells were deposited, much like those of the living Virginia oysters. Swimming reptiles, called plesiosaurs, with oar-like limbs, came far inland, just as dolphins range well up the Amazon River today.

The strata above the oyster-bed zone are physically similar to those below, except that coal seams are fewer and thinner. Dinosaur skeletons also are less numerous, but the most striking change is among the duck-billed dinosaurs. Instead of the flat-headed kind, the so-called hadrosaurines, we now see a preponderance of the hooded species, known as lambeosaurines, in which the skull is relatively short and the nose bones are extended back over the top of the brain case, carrying the nasal passages along with them, thereby forming a kind of hood or crest. This curious arrangement has been explained as an adaptation to underwater feeding or as a resonator to amplify vocal sounds.

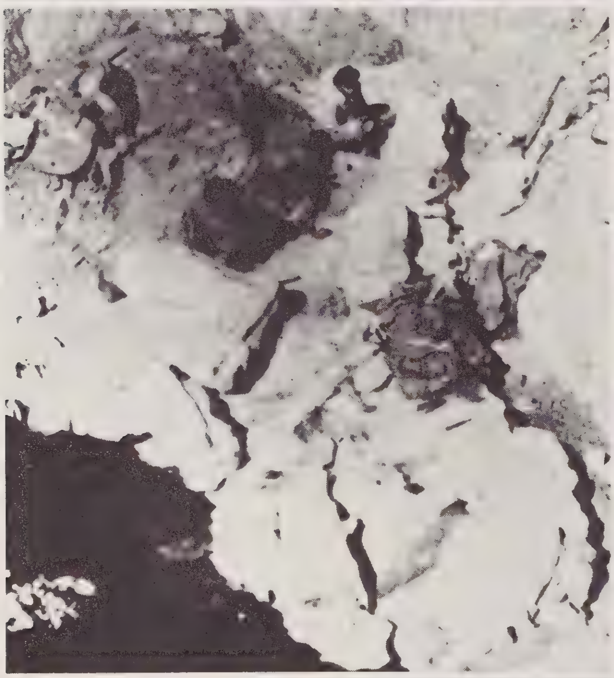
It is more intriguing to speculate why the hooded duck-bills displaced the flat-heads. Hooded forms were not new, for they are relatively abundant in the Oldman Formation in Dinosaur Provincial Park. The hooded duck-bills, if they had the ability to feed under water, were better adapted to the estuarine conditions near the inland sea. When this sea withdrew to the east the hooded duck-bills followed it, and they were replaced by the more terrestrial flat-heads. When later there was a partial return of the sea, as represented by the oyster beds, conditions were reversed for a time in favour of the hooded forms. However, they too gradually disappeared.



COURTESY L. RUSSELL

Loris Russell (*left*) and Maurice Stefanuk (*right*) stand near the site of Tyrrell's 1884 dinosaur fossil find at Kneehills Creek.






NATIONAL MUSEUMS OF CANADA

In the upper strata of the Edmonton Group, coal seams are once more conspicuous but dinosaur bones become even scarcer. The beginning of the last page in the last chapter of dinosaur history is recorded in the Scollard Formation, the uppermost part of the Edmonton Group. Here the duck-billed dinosaurs are poorly represented, the characteristic plant eaters being the large-horned dinosaur *Triceratops,* which had displaced the smaller *Anchiceratops.* A contemporary was the largest of all land predators, the six-metre high *Tyrannosaurus,* a giant version of the earlier *Albertosaurus.* Neither *Triceratops* nor *Tyrannosaurus* seem to have been numerous, and finally a level is reached where the bones of these and other dinosaurs are no longer present. The dinosaur graveyard had received its last interment.

The time of this event is recorded by the radioactive clock. Volcanically derived sediments at this level show a measurable amount of decay of radioactive potassium that has taken place since the time that the sediments were deposited. As the ratio of the rate of decay of this element and the corresponding production of argon is known, the elapsed time since the close of the age of dinosaurs can be determined: approximately sixty-four million years ago.

What brought about this conclusion to an era? There have been numerous suggestions of a sudden and major catastrophe. One hypothesis assumes that an enormous meteoric object crashed to earth, giving rise to vast clouds of dust that obscured the sun. Another theory is that the fall-out from a nearby stellar collision altered the atmosphere and changed the climate. However, the distribution of dinosaur fossils in the Edmonton badlands, as revealed by my investigation, supports an interpretation of gradual and selective extinction of each dinosaur species at different times in different places. This may have been brought about by slow but major climatic changes to which dinosaurs were unable to adapt.

The burial sites can provide information about how the dinosaurs died. It is noteworthy that the occurrence of more than one skeleton at a single site is rare, although it does happen. The so-called bone beds where large numbers of bones are piled haphazardly together appear to be the result of post-mortem events, such as floods. Most of the skeletons were complete before the erosion of the enclosing rock that has occurred since the last glacial age, forty thousand years ago. Sometimes the animal's skull is missing; this may be because the skull is a compact object that can drift away from the disintegrating carcass. Even where the skeleton is represented by parts only, such as a portion of the vertebral column, the conditions of the burial sites suggest natural disintegration rather than dismemberment by a predator. In a deposit along the North Saskatchewan River near Edmonton, bone fragments are common that show regularly spaced grooves, obviously the tooth marks of a carnivorous dinosaur. Perhaps this was a killing site. I've found nothing like this in the Edmonton badlands.

The common posture of the fossil duck-billed dinosaur skeleton is that of lying on one side, with the tail stretched out, the hind limbs flexed, the front limbs extended, and the neck and head bent back over the shoulders. There seem to be no signs of struggle; the dinosaurs appear to have quietly collapsed on their sides in the mud. Much the same posture is displayed by the fossil skeletons of the flesh-eating dinosaurs, and even the small bird-mimics.

Horned dinosaurs were strictly quadrupedal, and the usual posture of their fossil skeletons is lying on their undersides, sometimes with even the skull upright. Skulls of these dinosaurs are frequently found separately.

Many more observations have to be made or checked before the evidence on death and burial of the dinosaurs is fully gathered and interpreted. These observations and interpretations constitute the relatively new science of taphonomy, the study of burials. But the record preserved in the Edmonton badlands, like that of other dinosaur graveyards, is so extensive, so complex, and often so contradictory, that it will be a long time before we have achieved a detailed and fully accepted interpretation of what happened to the dinosaurs in the closing stages of their existence.

Facing page:
Top left: A quarry is opened in 1923 by Charles Sternberg. *Top right:* In the quarry, the fossil remains of *Edmontosaurus* are found encased in the surrounding layer of rock. *Middle left:* The surrounding layer of rock (concretionary layer) is being removed. *Middle right:* The rock under the fossil remains is being cut away so that the remains may be divided into sections that will be encased in protective plaster coatings. *Bottom left:* In an earlier excavation of 1916, G.F. Sternberg's team lowers plastered sections of *Edmontosaurus* to the road below. *Bottom right:* In 1923, a plaster-covered section of *Edmontosaurus* found by C.M. Sternberg is hauled away over an improvised road.

Dr Loris Russell is curator emeritus of the Department of Vertebrate Palaeontology, ROM.

Bringing the Dome to Yemen

Edward Keall

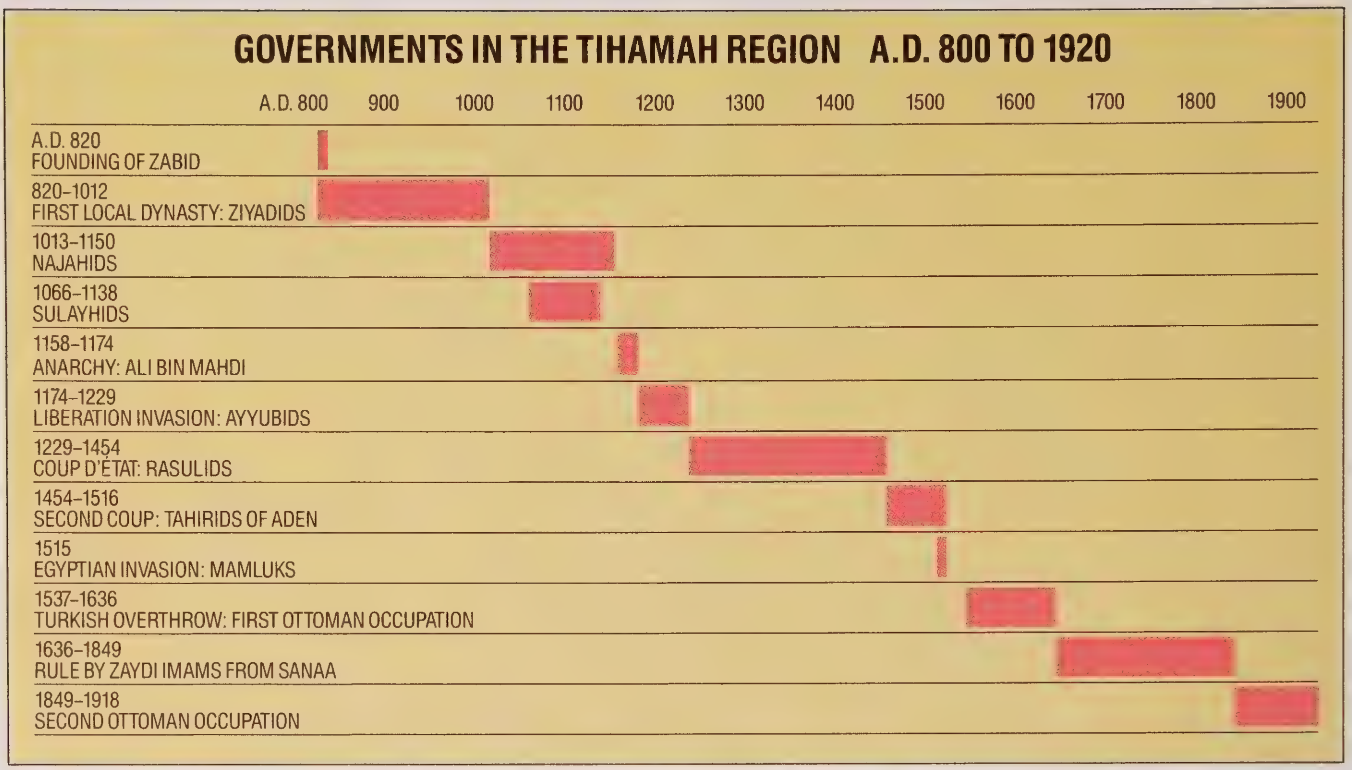
Having closed itself off from the outside world for most of this century, Yemen had become only a passing thought in the minds of Western scholars. Archaeologists from the ROM are rediscovering the exotic cultural history of this ancient country.

WHEN the distinguished Egyptologist Ahmad Fakhry travelled in 1947 to what is now the Yemen Arab Republic (North Yemen), he did so with permission from the king, Imam Yahya. The royal permit, one of the very few ever issued to outsiders, allowed him to travel from Aden by car to Taizz in the lower reaches of the high mountains. From there he was permitted to take mules along a route that had been travelled by caravans carrying incense and spices to the markets of the Mediterranean in the first millennium B.C. The focus of Fakhry's attention was Sabaean civilization, which draws its name from that of its most famous personality, the Queen of Sheba, who lived around 1000 B.C.

Four years after Fakhry's visit, Wendell Phillips led the first real archaeological expedition into the country under the banner of the American Foundation for the Study of Man. He was able to begin work almost immediately, excavating structures associated with the country's most famous ruin, the

PHOTOGRAPHS BY E. KEALL

A view of the ceiling of the al-Ashrafiyah, the most ornate of the Rasulid mosques in Taizz



JAMES LOATES

Marib Dam, whose collapse was traditionally blamed for the decline of Sabaean civilization. The dam had been situated on a seasonal watercourse that flowed out of the Yemeni highlands. Because of its notoriety, archaeologists invariably focused their attention upon the eastern slopes of the highlands where the Sabaeans farmed.

In 1980 when ROM researchers were considering field work in Yemen, they saw no reason to fight for a spot in the hotly contested arena of Marib. Instead they turned their attention to the west side of the highlands and to the coastal plain flanking the Red Sea, where another fascinating aspect of Yemen's history remained unexplored: the time of medieval Islam, between 800 and 1600, when Chinese captains sailed in the Indian Ocean and Arab merchants regularly put into Canton. During this epoch Yemen played a strong role in the commerce of Arabia, India, and East Africa.

The history of the cultural contacts that arose from Yemen's commercial enterprise has been badly neglected in the past century of western scholarship. Islamic architecture of Yemen remained largely a secret because of the travel restrictions that were imposed from World War I until the early seventies, when the country began to open up its doors again after a long, protracted civil war following the establishment of the Republic in 1962. K.A. Creswell, the great pioneering scholar of Islamic architecture, never visited Yemen; his monumental works, written between the 1920s and 1940s, have no references to Yemeni mosques.

The research team from the ROM decided that the raw material of their expedition was to be sought in and around the town of Zabid, once an important economic and administrative centre as well as the seat of a university. Their choice was based on the Museum's interest in the development of Islamic cities and their buildings, both as architectural monuments and as structures that reflect society's needs and aspirations.

Top: The northern part of Zabid as seen from the roof of a mosque
Bottom: The north gate of Zabid

Understanding how a dry streambed has cut down through the fields is part of learning about the ancient environment.

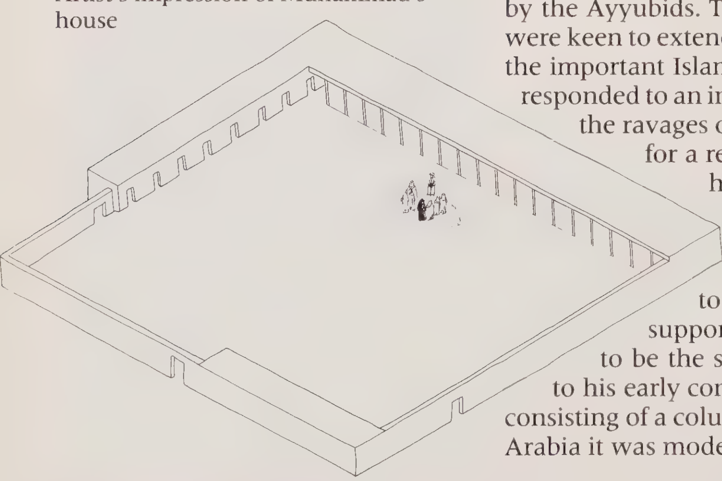
In 1982 with permission secured from the Yemeni Department of Antiquities and Libraries for the exploratory part of the project, the team of six ventured out into territory that had never been explored systematically by archaeologists. The long-term objective of the mission was to develop a picture of Zabid's great medieval past. The first step was to identify Zabid's position in relationship to the surrounding area. Anything and everything could be considered for use as a way of judging the strength of Zabid as a political, economic, and cultural centre: sites, city walls, mosques, dykes, shore-lines, markets, highways, and works of art. The team began by exploring mosques and minarets still standing from the days of Zabid's famous past.

The Grand Mosque, named for its important role in providing a house for the community of the faithful on Fridays, was founded at least as early as the 9th century. An even earlier date could be claimed for the al-Asha'ir mosque, named for the tribe that used to water its flocks in the area in the 8th century, before Zabid became a town. Whether anything that is still visible in either mosque can actually be demonstrated to date from the 9th century or earlier is questionable. It is immediately obvious to the eye, as well as being documented in historical texts, that both structures have undergone considerable repairs and even rebuildings.

In the early 13th century major renovations and enlargement were effected in the Grand Mosque as part of a deliberate policy of pacification of the country by the Ayyubids. The Ayyubids, who controlled Egypt and Syria at the time, were keen to extend their influence over the Arabian peninsula, which housed the important Islamic shrines of Mecca and Medinah. Therefore they quickly responded to an invitation from the citizens of Zabid to help them fight against the ravages of a charismatic Mahdi, who had terrorized the countryside for a religious cause. A minaret built by the conquering Ayyubids heralds the Grand Mosque from afar.

The re-built Grand Mosque is linked in architectural terms with the so-called hypostyle mosque of the Arab world. It is a building type based on the use of columns to support arcades across which are laid wooden beams that support a flat roof. Its prototype is generally accepted by scholars to be the sort of house that Muhammad lived in when he preached to his early converts in Medinah. Written records describe a simple house consisting of a columned shelter bordering a courtyard. In the warm climate of Arabia it was modest but adequate accommodation.

Artist's impression of Muhammad's house



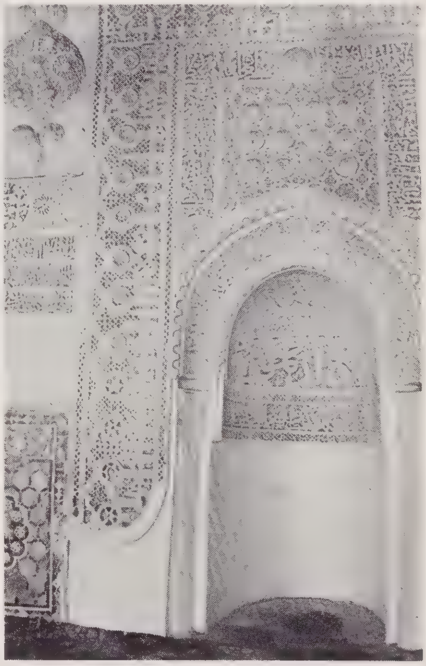
After Muhammad's death, Islam spread rapidly beyond Arabia. Wherever the conquering Arabian armies marched, the commanders built mosques for their troops. These first mosques used the Medinah house plan as a model. In North Africa to this day, when a mosque is built in a traditional way it retains an unmistakable link with the concept of a columned shelter around a courtyard, even though its structure is greater in size and complexity.

The entrance of the Asha'ir Mosque. To enter the mosque it is necessary to take steps down from the street level, which has risen over the centuries.

Left: The court of the Grand Mosque of Zabid

In the Grand Mosque of Zabid, there are two small domes that punctuate the roof line along the sanctuary aisle, that is, the lateral aisle that precedes the area of the *mihrab*, the niche that indicates the direction towards Mecca. The *mihrab* is the holiest part of the mosque, and this is stressed by elaborate decoration. But the domes and the decoration of the *mihrab* were not part of the original design. They were added in the late 15th century by an energetic Tahirid sultan who had embarked on a lavish program of mosque building and reconstruction. At this time the Tahirids were ruling Yemen from Aden, and enjoying the wealth gained through trade from the Indian Ocean. An elaborate inscription in ornate Arabic, which runs the entire width of the mosque, states that the mosque was rebuilt in the year 1492. This date is repeated in another inscription located to the left of the *mihrab* and on a carved door lintel. In spite of the sultan's claims to power as Commander of the Faithful (literally meaning head of all Muslims), Yemen's prosperity was soon to become dependent upon the whims and intrigues of Europeans who would enter the Indian Ocean in the wake of the Portuguese.

The *mihrab* of the Grand Mosque, which worshippers face during prayer, indicates the direction of Mecca, the holiest of Islamic sites.



The two small domes on the Grand Mosque were typical of architecture built in Yemen during the Tahirid dynasty. Ayyubid mosques in Yemen did not have such domes, although they were a feature on Ayyubid mosques throughout the rest of the Islamic world. Therefore sometime between the 13th and 15th centuries, the use of domes was introduced to the mosques of Yemen.

The introduction of the dome to Islamic architecture of the Middle East actually began as far back as the 11th century, when invaders from Central Asia conquered Iran from the northeast and started to develop projects that would make Iran a trend-setter in monumental architecture. The conquerors commissioned buildings based on architectural themes of the fire-temples of pre-Islamic Iran. More of these invaders entered Asia Minor (Turkey), where they destroyed the Byzantine armies, and made the country Islamic. Architects patronized by the conquerors were encouraged to experiment with the old domed style of architecture; they did, developing a totally new style. Domical architecture spread into Egypt and India as well. To the modern western eye, a domed mosque is the clearest sign of an Islamic building.

Though they built mosques with domes in their major centres in Syria, the Ayyubids did not introduce domes when they enlarged and repaired the mosques of Yemen in the 12th and 13th centuries. It was the Rasulids, a vigorous dynasty that started with a coup against the Ayyubid occupation forces in Yemen in 1229, who were responsible for starting the tradition of domical architecture. This tradition was continued later by the Tahirids. The Rasulids ruled for 225 years. Their mosques in Taizz, a city largely founded by them in the mountains to the southeast of Zabid, are unique in both their form and in their decorative schemes. The source of the new style is still undetermined. At present one can only suggest that it appears to be the result of a successful mesh of local vernacu-

The ornate al-Ashrafiyah mosque of Taizz (*left*), in its idyllic setting, is a dramatic contrast to the Citadel Mosque of Zabid (*below*), which formed part of the city's barracks.

lar architectural traditions (of brick and plaster) with the newly introduced dome. But whether the architects were influenced by the Syrian background of the Rasulids, by Yemen's contacts with India through trade, or something else entirely remains to be seen.

In Zabid, the new domical style is represented by the Citadel Mosque, named for its incorporation within the newly built exterior wall of the town's citadel (probably around 1800). The building's use as a barracks' mosque and potential point of defence has done nothing to enhance the structure's condition of repair. Over the years, in order to combat the gloomy interior, the mosque's guardians have thrown whitewash against the building's walls by simply using a can

dipped into a pail. Without going to the expense and effort of erecting scaffolding, the painters have been able to reach only the lower part of the dome. At the peak of the dome, the original painted ceiling can still be seen, although stains from water leaks and bats have damaged the designs.

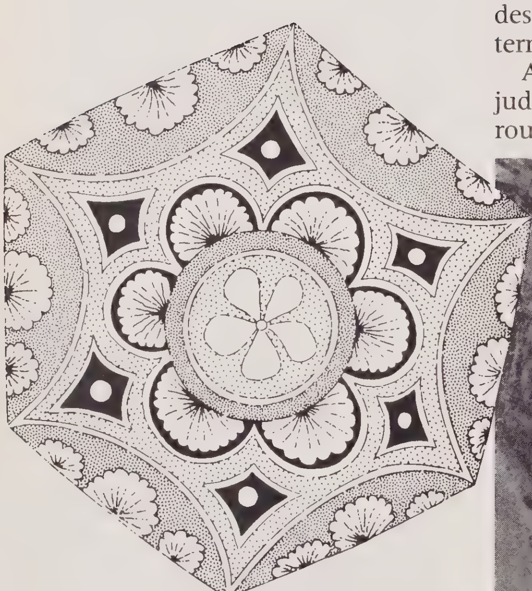
Nancy Willson, one of our team members, dedicated herself to recording the designs on paper while kneeling on the floor and reading them through binoculars. This was an uncomfortable task made more difficult because the geometric designs on the curved surfaces of the ceiling had been deliberately distorted by the artists so that they could be read correctly from the ground.

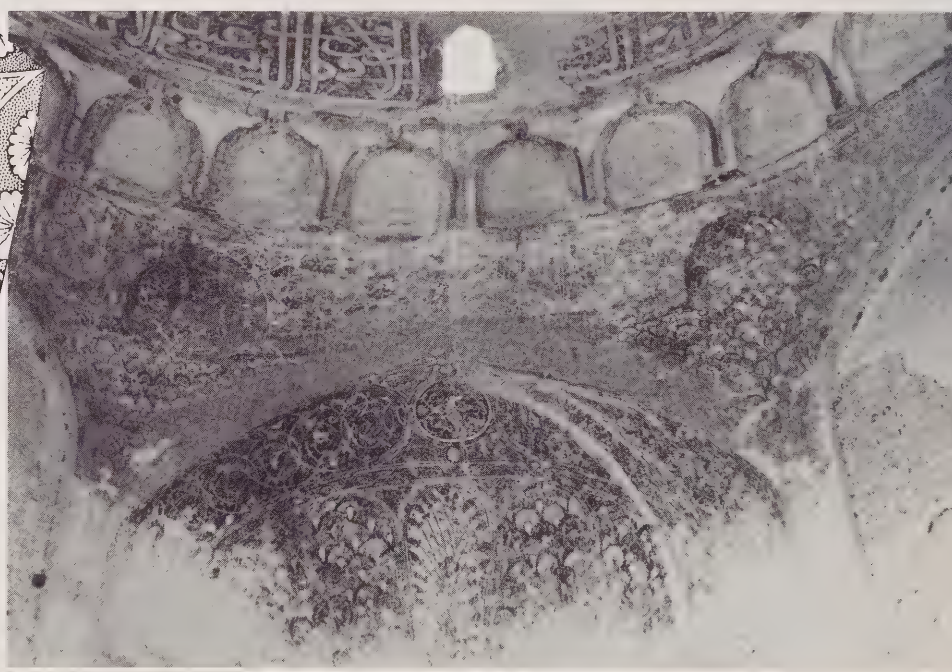
Tradition states that the Citadel Mosque, known locally as the al-Iskandariyah, was the work of Iskandar Mauz, who is known to have been associated with a small military contingent that was part of a larger invasion of Yemen by the Mamluk rulers of Egypt, in 1516. The invasion was a success, but the Mamluks were defeated back in Egypt in a battle against the Ottomans. As a result, the Ottomans fell heir to Yemen.

The troops of Iskandar stayed in Yemen after this coup, ruling there on behalf of the Ottomans until the arrival of a Turkish governor some twenty years later. Because of this Turkish association, the mosque attributed to Iskandar has been dismissed by scholars as another "dilapidated Ottoman-period mosque in an obscure province". Close inspection of the minaret of the Citadel Mosque reveals that, before being incorporated in the citadel wall, it was free-standing at the southeast corner of the mosque. Furthermore, the minaret was built after the mosque, and it can be dated by the ornate inscription in Arabic that embellished its exterior to the 14th century. With the order of building being first mosque, then minaret, and finally citadel, there is no difficulty in ascribing to the Citadel Mosque a pre-Turkish date.

In the Rasulid period, Zabid is known to have been an important administrative base as well as a traditional market town, with commercial and industrial activity commensurate with its role as a regional centre. The university was active. One of its most famous students, an Iranian named al-Firuzabadi, was a leading compiler of Arabic lexicons. Even some of the Rasulid sultans were active scholars. One wrote a treatise on agriculture, a medieval almanac with descriptions of seed types and planting times. (Of course, almanac is an Arabic term and can be loosely translated as climate calendar.)

Although Taizz is commonly thought of as the summer capital of the Rasulids, judging by its architecture the sultans actually may have lived there all year round. Even if the Rasulid princes preferred Taizz, it would have been odd for





Above: One of the ceiling decorations of the Citadel Mosque, which were carefully recorded by Nancy Willson, a member of the ROM team. *Right:* The ceiling exposed where the whitewash did not reach.

Left: The Citadel Mosque with its minaret is incorporated into the citadel wall.
Below: A residential quarter of Zabid

them not to have commissioned any mosques in Zabid, which was at least still an important administrative centre. At the same time, its modest proportions and peripheral location make it possible to speculate about the role the mosque may have played in the life of the town.

The traditional pattern of an Islamic town is a division into separate quarters, each defined by ethnic, religious, or social function. In residential areas, neighbourhoods evolved without any planned symmetry or grandiose vistas created from the alignment of buildings along streets. In the words of the urban anthropologist they were formed by "organic growth".

Often each residential quarter had only a single access road, which could be closed by a locked gate. While this system could be easily abused by a tyrant who wished to restrict people's movements, it was also a clever way to protect property and residents against intrusions by undesirable outsiders. The governor of a town resided in a separate quarter protected by the army, for he was invariably a political appointee of the sultan and therefore a possible target for attack. To avoid assassination, the governor may have limited his exposure to the public by performing his daily prayers at a mosque close by his home. He may only have ventured into the public arena of the Grand Mosque with the full protection of the army on grand ceremonial occasions.

Although the Rasulid dynasty was not hostile, it did introduce new legislation, which naturally would create some opposition. Being a university town, Zabid may have resisted change imposed from the outside, either as a reflection of an innate conservatism or of a latent rebelliousness. Consequently the Rasulids may have preferred to erect their grandiose architectural creations in Taizz where there was no university, while in Zabid building a mosque to serve the government's needs in a quarter of its own design.

Whatever the attitude of the Zabidi citizens there is no question that the Rasulids had a very strong impact upon Yemeni culture, particularly in matters of architecture. Dating from the Rasulid dynasty, all mosques in the lowlands of Yemen have at least one dome. The landscape is dotted with small mosques that invariably all bear a common stamp. Some of the details change, and there are buildings made up of single-, double-, and triple-domed units. But there is a model that the architects follow in terms of how one encloses space.

The origin of the domed form of the 13th-century mosque in Yemen may well be in Syria, where the Ayyubids and the Rasulids had their roots. But this is pure speculation at the moment and must be carefully researched. The subsequent development of the Yemeni mosque had a great deal to do with how mosques evolved in western India, where Yemen had trade contacts, although it is not known in which direction the architectural influences travelled. What we do know is that Yemen's contact with the outside world was far greater and more interesting than the isolation imagined by western scholars for the last hundred years.

Dr Edward Keall is curator in charge of the West Asian Department, ROM.

SCIENCE ON THE RUN

Facts or show biz—

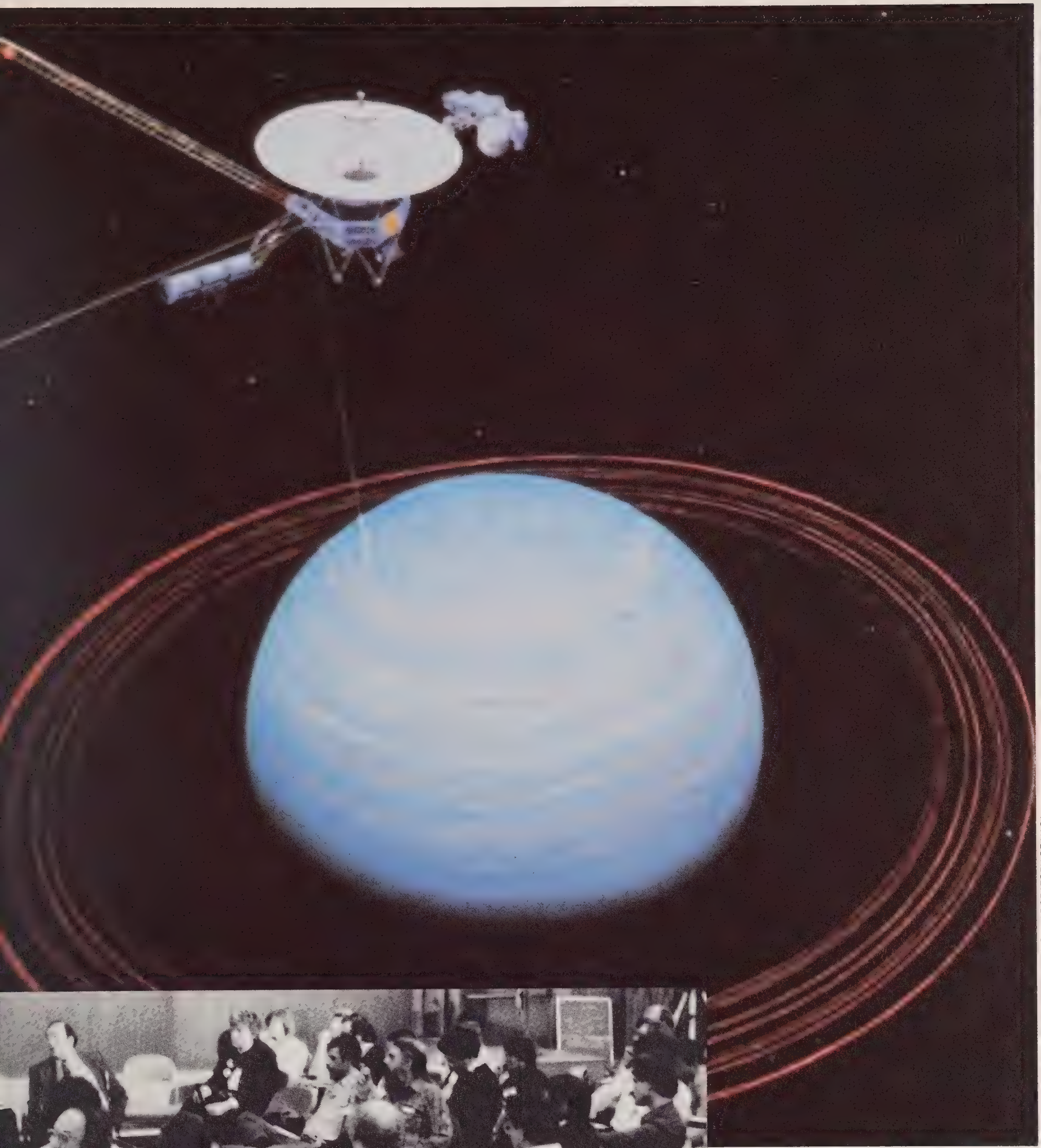
how accurate is the instant news we get about space missions?

Paul Deans

INSTANT science is a scientific process unique to the field of planetary exploration. It demands that a scientist, while facing a gathering of reporters and camera crews, provide on-the-spot explanations of the newly revealed mysteries of the solar system, based on data and photographs that have arrived from deep space less than twenty-four hours before. This is, of course, a complete reversal of the usual scientific method that requires months and even years to pass before a discovery is announced and explained. Yet instant science does work.

The idea of instant data analysis was born in 1976 during the Viking missions to Mars. The process was refined during the Voyager flybys of Jupiter in 1979 and perfected during the flybys of Saturn in 1980 and 1981. Much of the information collected from these missions has now been carefully scrutinized, and the record of the Viking and Voyager project scientists is astounding. While details may occasionally have been incorrect, the broad picture of the planets, moons, and rings that emerged during those hectic days of instant science has remained remarkably intact.

But the instant analysis of data arriving from Uranus posed a greater challenge than similar data analysis relating to Jupiter or Saturn. Lying 2.8 billion kilometres from the Sun, a considerably greater distance than the other two planets, the aquamarine gas giant and its family of moons and rings was far more of an enigma to astronomers. Voyager 2 would be the first spacecraft to visit the Uranian system. Scientists were uncertain whether the quantity and quality of the data from Uranus would match the expectations generated by the results of previous planetary flybys. Looking at the data that was transmitted during the days immediately preceding and following Voyager's encounter with Uranus, the flyby was anything but disappointing.



PHOTOGRAPHS COURTESY JET PROPULSION LABORATORY OF NASA

PAUL DEANS

Above: Artist's impression of the spacecraft Voyager 2 with its magnetometer boom extended towards the planet Uranus

Left: Scientists briefing reporters at a press conference during the Voyager 2 flyby of Uranus

"Why the rings should have different colours is not at all clear to us at this time."
Dr Bradford Smith, JPL
This is a computer colour-enhanced, close-up image of the rings of Uranus.

22 January 1986: Two days before the encounter

The first press conference of the Voyager-Uranus encounter begins in the Von Karmann auditorium, situated on the grounds of the Jet Propulsion Laboratory in Pasadena, California. After the usual opening remarks, Dr Edward Stone, chief project scientist, explains the tension and excitement felt by all those involved with the project by remarking: "For most of the science team members, this is it: a once in a lifetime shot at exploring Uranus."

Dr Bradford Smith is a planetary astronomer and leader of the Voyager Imaging Team, the group responsible for analyzing and interpreting the electronic images transmitted by the spacecraft. He is one of the most popular scientists with the media because of his dry wit and clear explanations, which he combines with an ability to provide snappy quotes almost on demand. But this time Dr Smith opens with a warning: "Uranus is not giving up its secrets easily . . . Instant science is always a dangerous thing, and when you're dealing with subtle phenomena, it becomes even more dangerous."

23 January: One day before the encounter

"Good morning and yes, there is radio emission from Uranus." Dr Ed Stone delivers the happy news; happy because it proves that Uranus does have a magnetic field. Astronomers now will be able to determine the planet's internal structure, as well as to calculate the length of a Uranian day.

However, it is already apparent that this encounter is different from the others. Voyager is now only 1.5 million kilometres from the Uranian cloud tops and a multitude of questions still cannot be answered. For the most part, this is simply because of a lack of light. Because Uranus is nearly twenty times farther away from the Sun than is Earth, sunlight reaching the Uranian system is only 1/400th as strong as the light that reaches our planet. Another difficulty lies with the Uranian system itself: the moons and rings are exceptionally dim. According to imaging team member Dr Richard Terrile: "The rings are extremely dark . . . and trying to photograph them is like trying to take a picture of soot against a black background."

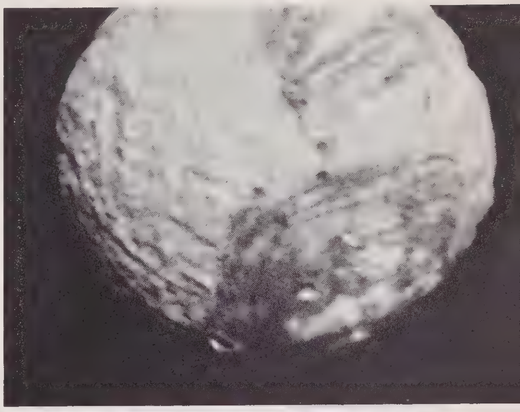
24 January: The encounter day

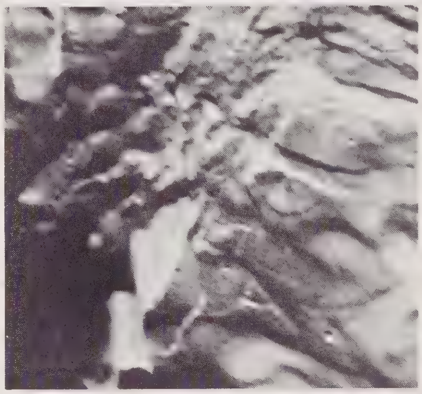
At 09:58:51 PST Voyager 2 sweeps to within 50 679 kilometres of the Uranian cloud tops. The press room is packed as Ed Stone describes the flyby as a "crescendo of discovery". But this description refers to Voyager's activity as it frantically secures information and images of the planet, rings, and the tiny moon Miranda, rather than to what is being discovered about them. Since the close-encounter data is stored on the craft's digital tape recorders for playback, scien-

tists and journalists must wait another twenty-four hours before receiving the results of this historic encounter.

Nevertheless, more facts are revealed, although comprehension does not necessarily keep pace with the flow of information. Dr Smith shows a number of close-up images of rings, and then a computer-coloured photo of the rings that reveals slight differences in the way that each of them reflects light. Some scientists suspect that different reflectivity implies different chemistry; Smith is uncertain.

To illustrate the dangers of instant science, Smith also shows several images of Miranda (the moon orbiting closest to Uranus of the five moons known prior to the Voyager flyby). On 21 January, a long-distance image of Miranda hinted that this moon might not be spherical. The next day a better photo discounted that idea, and showed what appeared to be a huge impact crater at the centre of Miranda. But in the image of 23 January, the crater seemed to be square instead of circular. Nobody wants to try to explain such an odd feature, so all the theories are placed on hold until the next day when the close-encounter images finally will arrive.





"It's incredible that an object this small could have this kind of geologic activity. It's just mindboggling! Miranda has been such a total surprise!"
Dr Laurence Soderblom, JPL

Top: Voyager 2 transmitted this view of the Uranian moon Miranda. *Bottom:* A close-up of the surface of Miranda

25 January: One day after the encounter

Many reporters have gone home just as the real science is beginning. Information revealed about the sharply tilted magnetic field, planetary chemistry, ring structure, and the three outermost moons are the highlights of the day's press conference, but the best is yet to come.

Later in the afternoon, the monitors hanging in the press room broadcast amazing images of the moon, Ariel, showing flow patterns, fault valleys, and craters. These are followed by a series of stunning photographs of Miranda that leave scientists and hardened space journalists gasping in amazement.

As new pictures arrive every 14.5 minutes, several members of the imaging team find their powers of analysis as well as themselves being sorely tested. Coerced into appearing on the "Voyager Update" television broadcasts that originate from JPL, the team members have no chance to pause to reflect on what they are seeing. Instead, they must provide a truly instant interpretation of each image. Furthermore, it is difficult to maintain a scientific composure before these astonishing pictures. As the first image of Miranda appears on the screen, Dr Gary Hunt exclaims: "Really, what a most extraordinary sight . . . it really takes your breath away!"

26 January: Two days after the encounter

"We never learn. I think no one could have anticipated even in an approximate way the exotic nature of what I'm going to show you this morning. We've had the same terrestrial, conservative view of Jupiter, of Saturn, and with Uranus we were surprised again. I wonder if we'll learn by the time we get to Neptune?"

With this comment, which applies to the past quarter-century of planetary exploration, Dr Laurence Soderblom, deputy imaging team leader, introduces the wonders of the five major Uranian satellites. The moons steal the show as unexpected evidence of past geological activity appears on each world. But as is often the case, there is an exception. Umbriel, the dark middle moon of the five previously known satellites, shows no signs of the tectonic turmoil that has twisted and scarred the faces of its neighbours. This causes some concern among the planetologists, but the worry is swept away in the excitement over Miranda.

"If you can imagine taking all the bizarre geologic forms in the solar system and putting them on one object, Miranda is it." says Soderblom. The geologists on the imaging team are staggered by Miranda. An unofficial term emerges that describes all they are able to do at the moment—SWAGGING, short for Stupid Wild-Ass Guessing.

27 January: Three days after the encounter

The geologists have retired until the next round, taking their battered theories

with them. Nonetheless, a bundle of new discoveries keeps everyone's interest high. Results from various experiments suggest that a shortage of small, reflective particles within the rings is the reason for their exceptional darkness. There are also a number of newly identified but invisible ringlets or ring arcs located beyond the bright, outer Epsilon ring. Uranus resembles its giant gas neighbours Jupiter and Saturn, but there are many important differences. A new feature called electroglow is described in some detail, but what powers it and why it appears only on the day side of Uranus remains a mystery. "We learn the most when we see things we can't readily explain", comments Dr Stone. "We are happily bewildered!"

28 January: Four days after the encounter

Today was to be the day of explanation, the day when all the theories, ideas, and observations would come together into a coherent instant theory of the Uranian system. But the space shuttle Challenger has exploded in front of a disbelieving audience of scientists and journalists. The wonders and mysteries of another world are postponed for a day as everyone grapples with the tragic reality of the shuttle disaster.

29 January: Five days after the encounter

The final press conference is held and the instant science lives up to all expectations. Uranus is revealed as a unique member of the solar family; it is a giant gas planet that is similar to its cousins Jupiter and Saturn, but with some very individual personality traits.

An upper haze layer of acetylene drifts over deeper bands of methane cloud that are rich in complex hydrocarbons. Global atmospheric circulation is poor; the air above the planet's north pole (the one that has been pointed *away* from the sun for more than twenty years) is still warmer than the pole that is currently sunlit. A hydrogen/helium ratio of eighty-eight per cent is calculated, destroying a theory that suggested the presence of nearly forty per cent helium inside Uranus. Beneath the gaseous clouds lies a hot, electrically charged ocean of water, methane, and ammonia—the probable source of the planet's unusual magnetic field. An earth-sized core of rock lies at the centre of the planet.

The magnetic field is tilted fifty-five degrees away from the Uranian pole of rotation. If this were the case on Earth, our magnetic pole would lie near Los Angeles rather than in the Canadian Arctic. The field sweeps around the planet every 16.8 hours, providing astronomers with a measure of the length of a Uranian day. As Voyager scanned the night side of Uranus, it detected weak auroral activity. The electroglow, which dominates the dayside of the planet, is now explained as being caused by slow-moving electrons striking a vast sphere of hydrogen gas that envelops the planet. Weak electroglow was found at Jupiter and Saturn, but it is prominent at Uranus.

The rings remain puzzling, although some data have emerged. Each of the eleven visible rings is made of stove-sized chunks of ice and rock, and little else. The small particles that make Saturn's rings so spectacular are conspicuous by their absence at Uranus. In fact, if the total mass of the Uranian rings was squeezed together into a solid body, it would produce a tiny moon that was only ten kilometres in diameter. This moon would be smaller than anything currently orbiting the planet.

Other experiments showed that although the rings look simple, their overall structure is quite complex. Most of the visible rings contain several smaller components. An unknown number of tiny, invisible ringlets were discovered. Nowhere are the rings more than 250 metres thick (even though the entire ring system is over 100000 kilometres across). Since there is Earth-based evidence to suggest that ring particles may extend out past the orbit of Miranda, it may be that the invisible system of Uranian rings is far more extensive than the visible one.

Ten new moons were discovered, and there may be more buried in the photographs that have yet to be analyzed. But what of the five moons known to scientists prior to the Voyager encounter? Their geology still holds many

mysteries. In general the closer a moon is to Uranus, the more severe is the geological reworking of its surface. Astrogeologists still do not know why the middle moon, Umbriel, does not fit this pattern. A dark material found on several Saturnian moons is abundant in the Uranian system. This further supports the theory that the material is carbon-rich matter forced up from the interior of each moon. But how tiny ice and rock bodies like moons could generate and support such complex geological activity remains unknown.

The story of Miranda is apparently one of catastrophe. This moon has been shattered, probably more than once, by collisions with comets or asteroids. Obviously such impacts did not completely scatter the pieces forever. Rather, they slowly reformed into a jumbled world, with rock and ice randomly mixed throughout the satellite. The end result is the Miranda of today, a mixed-up little moon that is a geological mess.

15 February: Twenty-two days after the encounter

Voyager has recorded its last observation of the Uranian system. The scientists are beginning to disperse; the journalists have left. Although the mission has been an unqualified success, one item of unfinished business remains. Being conservative by nature, none of the project scientists wants to venture out on a limb by offering an explanation, even in general terms, of how the Uranian system came to be. Any such account will necessarily be rather speculative, but the Voyager flyby has helped fill in a few of the previously unknown details. When the facts and figures offered during informal briefings over the past month are combined with previous research, an extraordinary story unfolds.

Approximately 4.6 billion years ago, portions of a cloud of dust and gas that encircled the Sun condensed in various places over a great period of time to form Uranus and the other planets. Uranus probably had a family of moons resulting from leftover debris surrounding the planet; it may even have had rings. But there were also a lot of planet-sized chunks of rock and ice debris floating around in the outer solar system. One of them smashed into the young planet, gradually tipping it over onto its side until it came to rest as we see it today. As Uranus toppled, its satellite system was completely destroyed by the changing tidal pull of the tilting planet. Once again, Uranus was surrounded by debris, and once again, a satellite system formed. Although Miranda was destroyed and rebuilt, eventually Uranus and its entire family settled down into the tranquil existence that we see today.

Voyager may have given scientists a sense of when these events took place. Astronomers can estimate the age of a distant planet or moon by counting the number of craters of various sizes present on a given surface area. The more craters there are, the older the surface. A specific age can be estimated by comparing these crater counts to regions on our own moon where the Apollo astronauts collected rock samples that have been carefully dated.

Applying this technique to the Uranian moons reveals that there does not appear to be a surface older than 4 to 4.2 billion years. On Miranda, most of the surface is even younger: somewhere between 3.5 and 3.8 billion years of age. If these initial estimates hold, it would mean that the Uranian system scrutinized by Voyager is almost a half billion years younger than the rest of the solar system.

After each outer-space mission, regardless of the wealth of scientific information collected, the same question is always asked: Why do we explore these worlds so far from home? Of course, there are the usual reasons that range from practical applications to pure scientific curiosity. But imaging team member Dr Andrew Ingersol perhaps answered that question best during an informal briefing that took place one day before Voyager's closest approach to Uranus. When asked what we learn by studying the planets, he replied: "Humility! Every time we have an encounter such as this, we learn just how much we don't know about the rest of the universe!" Voyager 2 gave us one more dose of humility before heading off toward Neptune and a final rendezvous with yet another unknown world.

"I don't know why I keep getting the feeling that Uranus is looking back at us."
Dr Bradford Smith, JPL

The top image of Uranus transmitted by Voyager 2 is not computer enhanced. The lower image of Uranus has been computer colour-enhanced after it was transmitted by Voyager 2.

Paul Deans is producer–astronomy at the Edmonton Space Sciences Centre. He formerly worked at the McLaughlin Planetarium of the ROM.

CATERING FOR

The success of manned explorations of our planet and beyond has depended more on food than one might imagine.

Nancy Willson

Of hunger and thirst, colde and wearinesse, there was no end. For they gave us no victuals, but only in the evening. In the morning they used to give us a little drinke, or some sodden Millet to sup off. In the evening they bestowed flesh upon us, as namely, a shoulder and breast of rams mutton, and every man a measured quantitie of broath to drinke . . . Sometimes we were faine to eate flesh halfe sodden, or almost raw, and all for want of fewel to seethe it withal.

translated from Latin in Hakluyt's *Voyages*, 1598

SO William of Rubrik, a 13th-century friar, described the miseries of his four-month trek eastward from the Caspian Sea. William was one of the first Europeans to leave a record of a journey into Central Asia, soon after it had been opened to western travellers by the conquests of the Mongols under Ghengis Khan. The European foods that he had brought to sustain him—dried biscuit, wine, apples, and other fruits—had given out. He had no gold, and his cheap European coin would buy nothing. William had no choice: he was forced to eat as his Tartar guides ate when on the move.

Like many a traveller before and since, William of Rubrik tended to equate the quality of his trip with the state of his stomach. In this totally alien environment, his hunger perhaps was intensified by culture shock. Nevertheless, the hardships that he experienced were real, and they derived from the same set of conditions that every explorer of unknown regions has faced. The distances they would cover, the time they would be away, and the conditions they would encounter were all wholly unpredictable. In these ventures, not only success but often survival depended upon the provisions which could be carried on the journey. Above all, these provisions had to be compact, nutritious, and resistant to spoilage.

Explorers in every age have relied heavily on supplies of preserved food, whatever its shortcomings. William of Rubrik's own foodstocks from Europe were processed by two of the most common methods of preservation: drying (his biscuits were made by using the double-baking process, which gave them their lasting qualities) and fermentation. These methods, like almost all of the others used to preserve foods today, are of very ancient origin. The techniques of smoking, dry-salting, pickling, packing in oil, and even freeze-drying, all date from prehistoric times. In the history of exploration—and especially of maritime exploration—the existence of food-preserving techniques has played as important a role as the development of navigational skills or advances in ship design.

We do not know for certain what provisions were taken by the earliest sailors to cross wide stretches of open water. However, archaeological and anthropological evidence allows us to make a fair guess. For their early explorations of the North Atlantic, the Irish and the Vikings probably stocked their ships with a variety of meats preserved by drying and possibly by pickling and smoking. Cereals and root crops had natural keeping qualities as long as they were kept dry. Supplies of fresh water were stored in leather flasks or wooden casks. To sustain their health, sailors would supplement this diet at every opportunity

A Mongolian woman prepares a popular beverage made from a mixture of tea, millet, dried and liquid yak milk, and yak butter. The beverage is made from a recipe that is centuries old, and probably it is similar to the food that William of Rubik was fed during his journey across Central Asia.

COURTESY WAYNE SCHLEPP

THE UNKNOWN

NASA

As the meal in space indicates, extra-vehicular activity, satellite rendez-vous, and tool-making weren't the only things that kept the crew busy on this week-long, American space shuttle flight.

with fresh fish and the fat-laden meat of sea mammals such as seals. On such foods St Brendan, the 6th-century Irish abbot, survived a voyage of seven years, including one three-month period when land was never in sight. A few centuries later, after their initial exploration of the North Atlantic islands, the Vikings used the same types of provisions on their twenty-four-hundred-kilometre journeys to Greenland and beyond.

Remarkable as these voyages were, similar feats of navigation had been achieved in the Pacific Ocean over a thousand years earlier by the seafarers who colonized the Polynesian Islands. These migrations are generally believed to have originated in Southeast Asia, passing by way of Melanesia and Micronesia en route to the mid-Pacific island groups. Before departing, boats could be loaded with a plentiful supply of fresh produce, fish, and meat from domesticated animals and shorebirds. However, beyond the broad sea shelf that surrounds the island clusters, the Pacific is surprisingly barren of sea life. As the colonizers voyaged hundreds of miles across open water, their on-board stores of preserved food were critical to survival.

Skills that were still common in the south Pacific when Europeans began to record the life there lead us to believe that the Polynesian settlers had a well-developed food preservation technology to serve them on these voyages. Fish were commonly dried or salted. Several types of fruit could be preserved by fermentation and by drying, with or without prior smoking. Chief among them

was probably breadfruit, which had extraordinary keeping qualities when fermented. Inhabitants of the Marquesa Islands claimed that fermented breadfruit was at its peak when ten years old, but it could last up to a century. Pandanus fruit could be rendered almost as durable by processing it into flour or a paste-like preparation. Banana pulp, sun-dried to a gum-like consistency, lasted indefinitely and had the quality of a delicious confection. These foods were simply bound in a wrapping of leaves for long-term storage. Coconuts provided both meat and drink in a natural storage container, while water would likely have been stored in gourds or hollow bamboo canes, containers that would keep the contents sweeter than the wooden casks used aboard European ships.

When European explorers first ventured into the Pacific, the provisions they took were far different. Magellan's ledger, in which he itemized the foodstuffs for his 1519 voyage around the globe, still exists. His list is of interest not only for the information it gives on the diet of a southern European sailor at that time, but for the quantities that Magellan estimated would be necessary for his crew of approximately 270 men. Several protein foods are specified: 2817 pounds of cheese, 150 barrels of anchovies, 10 000 sardines, and three bushels of beans. Salted pork and beef, the protein staples found on most later ocean voyages, are not included. However, the expedition would have taken livestock aboard before leaving Seville, with the expectation of replenishing the supply of fresh meat along whatever coastlines they reached. Although the ledger lists only 800 pounds of flour, ship's biscuit undoubtedly formed the bulk of carbohydrate food for the sailors. For other nourishment, Magellan stocked 250 strings of garlic buds, 1352 pounds of honey, almost 2000 pounds of raisins, 200 pounds of prunes, and a bushel of almonds.

Magellan reached the Pacific the following year. His next goal was to reach the Molucca Islands which lay on the far side of this body of water. He was confident of finding them by sailing along a certain line of latitude, but he made the mistake of believing that they were only a short distance away. As a result, he failed to replenish his food supplies before sailing out from the South American coast. Magellan and his men now endured a passage of three months and twenty days without fresh food. Pigafeta, his chronicler, described this passage. The men, he wrote, survived on

> biscuit, which was no longer biscuit, but powder of biscuit swarming with worms, for they had eaten the good. It stank strongly of the urine of rats. We drank yellow water that had been putrid for many days. We also ate some ox hides that covered the top of the mainyard . . . and often we ate sawdust from boards. Rats were sold for one-half ducado apiece, and even then we could not get them.

Scurvy and other diseases attacked the crew. When they finally made a landfall at Guam, they were able to take on some fresh supplies, but it was not until the ships reached the Philippines that the crew members were able to rest and take their fill of fresh food and water again.

For the next three centuries, the health of the common sailor often depended on the distance to the next safe landfall where fresh food and water could be obtained. The jaw-cracking ship's biscuit could last for years, and frequently had by the time it reached a sailor's plate. Sailors formed the habit of tapping a biscuit before eating it in the hope of dislodging the insects that tended to infest opened stores of biscuit. Salt beef or pork was the normal protein staple. Salting destroyed valuable vitamins in the meat, and in hot climates the product did not keep well. Furthermore,

One of the stops on Ferdinand Magellan's circumglobal voyage was the southern tip of South America. On the offshore islands, Magellan's crew found penguins, which they bludgeoned to death in their hundreds. The meat of the penguins was salted for food, their blubber was melted down for lamp-oil, and their pelts were sewn into clothing and other articles.

BRITISH MUSEUM

if improperly prepared, salted meat could leave a sailor very thirsty. Another source of protein, dried legumes such as marrow-fat peas, were used to supplement or to substitute for the salted meat.

Water was the single staple of a shipboard diet for which there was no preservation method. Stored in wooden casks it quickly lost its freshness, eventually becoming green and slimy with algae. Pedro Fernández de Quirós, the Portuguese explorer, set sail for the Pacific in 1605 with distilling equipment aboard ship to provide potable water for the crew. However, the amount of fuel required to distil water for a ship's crew for any length of time would be considerable, and such equipment never became a standard part of ships' outfitting.

Cromwell tried to remedy the problem by offering set rations of beer to the crews of the British navy. It was found, however, that the keeping qualities of beer, poor in any case in the 17th century, were not improved by sea journeys. With the capture of Jamaica in 1655, rum was introduced as an alternative to beer. This also proved to have drawbacks, and in the following century, rum rations in the British navy were watered down in the interests of efficiency on board ship. Nevertheless, rum rations remained important to sailors not only for the thirst-quenching and fortifying effects, but because rum was thought to prevent scurvy.

C.W. JEFFERYS

In his book *A Picture Gallery of Canadian History,* C.W. Jefferys included an illustration of Jacques Cartier and his men praying that a remedy for their scurvy could be obtained from the Indians.

This disease was the great hazard faced by all travellers whose diets lacked fresh foods. Jacques Cartier, whose men had suffered severely from scurvy at Stadacona during the winter of 1535, wrote of it as *la grosse maladie*, and with good reason. When vitamin C is deficient in the diet, the crosslinks holding tissue protein together dissolve and the tissues separate. The disease affects every part and function of the body in a painful and progressively debilitating way. James Cook noted one of its symptoms: in older sailors, scurvy caused fifty-year-old wounds to reopen. But perhaps its most terrible effect was a loosening of the teeth due to swelling of the gums, which made it difficult for victims to eat the foods that might cure them.

By the time of Cook's famous voyages of Pacific exploration, it was clear enough that scurvy was caused by a dietary deficiency. Seamen had long been aware that those who could afford a private store of provisions on board a ship suffered less from the disease than those who were dependent on regular ships' rations. Because the British Admiralty had begun to show an active interest in maintaining the health of its men at sea, Cook was provided with several experimental foods: portable soup (a meat essence in cake form to be boiled with legumes or oatmeal) and reputed antiscorbutics like malt, sauerkraut, and sugared syrups of oranges and lemons.

Of these, only sauerkraut had a genuine effect in preventing scurvy. Cook formed a low opinion of the citrus syrups, which in fact lost their precious vitamin content through the boiling process that reduced them to this concentrated form. But he dosed his men with malt, portable soup, and sauerkraut when symptoms of scurvy appeared. More important, he insisted that they eat fresh foods at every opportunity, and taught them to forage for plant foods wherever they landed. So successful were these efforts that, as one of his crew put it, the men acquired the habit of eating "almost Every Herb plant Root and kinds of Fruit they Could Possibly Light upon", with the result that he lost no crew members to scurvy on any of his three voyages in the 1770s and 1780s.

Cook's concern for his men and his achievement in preventing scurvy were admirable. However, at least one proven cure for the disease had been known long before his day. Fresh citrus fruits and their juices were consumed in the early 1600s by English and Dutch seamen, who may have learned of the fruits' antiscorbutic qualities from Mediterranean sailors. In 1753, James Lind had published the results of careful experiments showing that a number of foods

such as citrus fruits and juices, "essence of spruce", and sauerkraut definitely prevented scurvy. Yet medical opinion remained divided. The value of citrus fruits in particular was called into question. Some condemned their use out of a conviction that a causative link existed between tropical fruits and tropical diseases. Then too, there appeared to be a clear piece of contrary evidence: the citrus syrups tested by Cook had had no curative effect whatever. Partly for these reasons and possibly because the British military establishment was extremely conservative, it was not until 1795 that citrus juice became regular issue in the British navy.

This was not the only cure for scurvy known to sailors by Cook's time; fresh meat was another. During a harrowing journey across the Pacific, one of the officers of 18th-century explorer Louis Antoine de Bougainville's crew described how scurvy had so damaged their mouths that it had become impossible "to relieve ourselves of the disease by eating any kind of fresh meat". Normally meat does contain vitamin C (almost all animals, with man as a notable exception, are able to synthesize it naturally), and only preserving methods such as salting destroy the vitamin.

In the late 1700s, while the British Admiralty was coming to its tardy realization that scurvy need not be a threat to British sea power, the problem of retaining essential nutrients in preserved foods was also being addressed. From experiments begun in those years, a French champagne bottler and confectioner named Nicholas Appert succeeded in developing a new preserving method, with foods bottled in glass and sterilized by heat. It was the forerunner of the canning process, and the first totally new food preservation process developed in millennia. Appert's bottled foods were tried out successfully by the French navy, and the Napoleonic government recognized the importance of the invention by awarding a monetary prize to the inventor.

The idea travelled across the English Channel, and by 1810 a canning technique had been developed in England which used tinned sheet-iron containers. The British Admiralty was an enthusiastic purchaser, and the new tinned provisions quickly became a valued part of ships' stores during the wave of early 19th-century Arctic exploration. Thus when Sir John Franklin stocked his ships for his fateful last Arctic voyage of 1845, his provisions included 58 500 pounds of tinned foods—soups, vegetables, and meats—to supplement the more traditional ship's fare. At this time, tinned foods were thought to retain the antiscorbutic qualities of the fresh ingredients. Nevertheless, Franklin ordered 9300 pounds of lemon juice for the voyage. This food supply was calculated to last three years for a crew of 133 men.

Ominously, nearly 15 500 pounds of the tinned provisions putrefied and had to be replaced before the ships left port. An undetermined quantity spoiled after the expedition sailed. By a further unlucky circumstance, the region of the Arctic in which Franklin's ships became permanently ice-locked was a sterile one, so devoid of animal life that it supported no human inhabitants. In the third year, 105 men remained, now suffering from scurvy and (as recent analysis of skeletal remains has shown) from lead poisoning, possibly due to faulty canning techniques. In the end, no one survived.

Later explorers who pieced together the evidence of the expedition's fate placed the blame above all on the "putrid abomination" found in the cans which Franklin's men had dumped on the ice. At the time it was believed that the fault lay with the Admiralty contractor who had processed the foods. It is true that he had been rushed, and had had difficulty in filling Franklin's order in time. But evidence of a quite different reason for the tins' spoilage soon began to accumulate.

Whether or not faulty manufacturing contributed to the disaster, it appears that Franklin's men were basically the victims of an experimental phase in the development of the canning industry. The expedition coincided with a trend towards canning foods in larger "packs" than had previously been used; these of course would be more convenient than small tins on an extended voyage. In the years following Franklin's voyage, a series of complaints about defective tinned foods led the Admiralty to conduct an inquiry, and to issue a ruling in

PHOTOGRAPHY DEPT, ROM

1852 that tins should not exceed the six-pound size. Larger sizes, the inquiry had concluded, tended to spoil because the contents in the centre of the can were not adequately cooked.

Tinned foods became a staple among shipboard provisions, valued not only for nutritional reasons but for the variety they added to the sailors' diet. But a ship's galley was capable of producing even more variety, given a generous captain, a well-stocked larder, and a skilled cook. The journal kept by Francis M'Clintock, leader of one of the Franklin search missions, describes the dinner prepared by his men on Christmas day of 1857. M'Clintock had issued the men with additional foods for the occasion.

The officers came down with me to see their preparations. We were really astonished! Their mess-tables were laid out like the counters in a confectioner's shop, with apple and gooseberry tarts, plum and sponge-cakes in pyramids, besides various other unknown puffs, cakes, and loaves of all sizes and shapes. We bake all our own bread, and excellent it is. In the background were nicely-browned hams, meat-pies, cheeses, and other substantial articles. Rum and water in wine-glasses and plum-cake was handed to us: we wished them a happy Christmas, and complimented them on their taste and spirit in getting up such a display.

M'Clintock's voyage, like the other rescue expeditions sent out to search for Franklin's men, had a second and equally serious purpose to fulfil in the Arctic. Much like the space missions of our own day, they carried out an enormous amount of experimentation on such factors as the environment and equipment. Experimental foodstuffs and technical changes to tin cans were tested for their ability to withstand the extreme environmental conditions. In a more thorough and far-reaching way than ever before, the element of chance was being eliminated. Exploration had become a highly scientific pursuit.

The Fate of Sir John Franklin's Last Expedition, watercolour, gouache, pen and ink, collection of the ROM.
The skeletons of two men, two guns, a rowboat, and some articles were found at Point Victory, King William's Island, by the M'Clintock expedition. Franklin's men starved to death because there was no wildlife to slaughter for food. The artist may have painted the birds flying overhead as spectres of a preferable fate.

Plastic packages contain a variety of space foods carried aboard the Gemini spacecraft during a space flight. The contents of the plastic containers equal the conventional meal in the foreground. A water gun was used to reconstitute the dehydrated space food.

NASA

Manned space flight is the most sophisticated form of exploration to date. But before any space mission could be launched, scientists found themselves up against a very old problem; supplying compact, nutritious, and spoil-resistant foods. To these traditional requirements a few new ones were added. Space food had to be easily digested, and it had to hold up under conditions of acceleration pressure and zero gravity.

For the food engineers, lack of gravity was the most unpredictable element. What would happen to food in a weightless environment? They speculated that it might explode, disintegrate, or fly out of open containers, and so to avoid such possibilities the earliest space foods were processed in two basic forms. One consisted of dehydrated solids and powders. These were vacuum-packed in flexible plastic packages, with a valve at one end through which water could be injected to rehydrate the food and a feeding tube at the other end. The second form of food was designed to be eaten without rehydration. Some of the natural moisture was retained in this type of food, and plasticizers such as glycerol were added to create preparations which could be eaten in bite-sized chunks.

From the first manned space orbits, scientists learned what does happen to food in space. Surface tension holds solid food together, and helps to keep it in its container. Liquid does not spray out if released from its container, but forms a floating sphere which could be sipped with a straw. However, for convenience, beverage containers are designed to allow the insertion of a straw without the escape of any liquid. A straw must be used for drinking in outer space. Without gravity the direction down does not exist, and therefore liquid cannot slide down the side of a container.

As engineers became more familiar with the nature of weightless environments, foods for space flights regained more familiar forms. All foods are now of the rehydratable type, but they can be easily recognized. Flight menus now include such items as barbecue beef, chicken à la king, and shrimp cocktail. Potable water is produced from the same cryogenically stored oxygen and hydrogen used to fuel the spacecraft's electrical generating system.

Although space foods are spoken of in high-tech terms such as designed and engineered, their preparation employs a technique that dates from prehistoric times: freeze-drying. Freeze-drying was used by the Peruvian peoples to preserve their potato crops long before ships from Europe began to discover and to explore their shores.

Nancy Willson was the researcher for the historical components of the Ontario Science Centre's special exhibition Food, *which continues until 2 November 1986. The exhibition is presented in co-operation with Ault Dairies/Catelli/Ogilvie: companies of John Labatt, the Ontario Ministry of Agriculture and Food, and the Ontario Ministry of Citizenship and Culture.*

What Did That Worm Say?

You may never have imagined that scientists would study an average, everyday earthworm, let alone its less familiar relatives in lakes and oceans. However, scientists do study worms, and they call them *oligochaetes*.

I am a scientist and if you were to ask me why I study worms I might say that it is because they tell me things, or if I felt poetic I might say that it is because they sing to me. The worms sing to me when I learn something particularly interesting or surprising about them.

It is true that worms can't speak or sing. Then how do they communicate? Communication of ideas can take place by means other than speech, such as sounds or signals. When a bird looks on a lawn for a worm for his dinner, we can see that first, it listens very carefully, then it dips its head and pulls back with a worm in its beak. The bird apparently heard the worm.

Worms move along underground either through old burrows or by pushing and eating through the soil, thereby making new burrows. As the worm moves along, its body scrapes the dirt particles, and the bristles along the segments of its body rasp the sides of the burrow. These are the sounds that tell birds where worms are in the ground. Worm sounds have even been heard by people when the worms were protruding partly from the burrows. These sounds were originally thought to be made through the worms' mouths, giving rise to the expression "singing earthworms".

For the most part, birds are better able than scientists to detect these movement sounds because the sounds are of more interest to birds.

COURTESY DEPT OF INVERTEBRATE ZOOLOGY, ROM

A tangle of worms. Worms intertwine when they are too crowded.

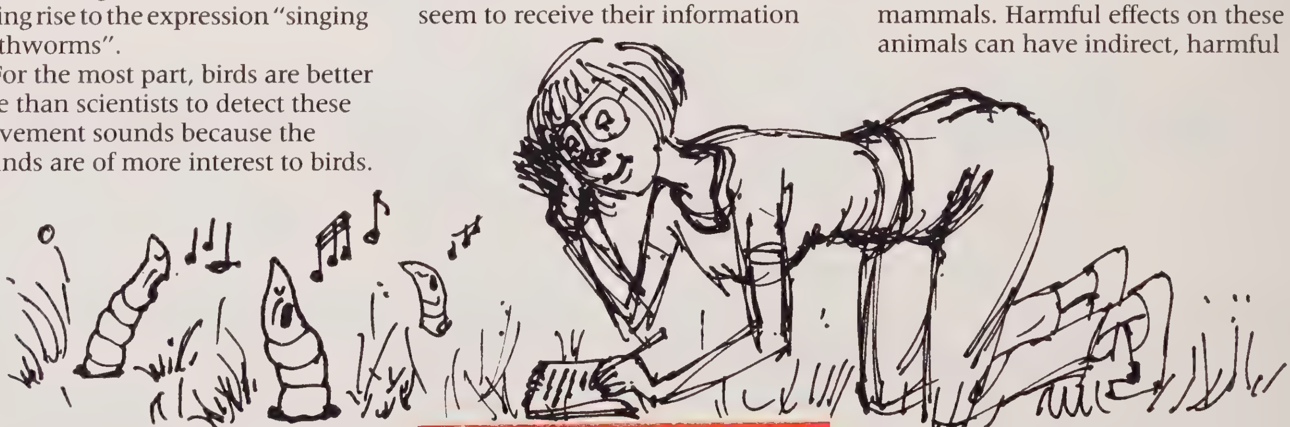
Scientists are more interested in the signals that worms make to each other and about their environments.

Worms respond to signals from other worms. Most often one worm must find another for the purpose of reproduction. Mating encounters between mature worms may be accidental, but it is possible that the encounters are arranged by sound or chemical signals. Scientific research indicates that chemical signals are more likely.

The oligochaete relatives of earthworms that live at the bottoms of lakes seem to communicate among members of the same and of different species. They indicate to each other where food is plentiful and rich. How are the signals sent and how are they received?

The receiving worms, the ones that are away from the food source, seem to receive their information through the water, but not directly from the worms at the feast. The information that is received comes from the castings (waste-matter) of worms that have already fed. Worms digest very little of the food found in the dirt that they eat. Most of it literally goes in one end and out the other. Therefore wherever a lot of worms have fed, there will be a lot of worm castings close by; an abundance of castings is a strong food signal.

Worms indirectly send us signals about their habitats. We have learned through experiments on feeding behaviour and by taking measurements at lake bottoms, that polluted areas are where many worms find their food. The conditions in these areas may not be good for other aquatic animals such as fishes, amphibians, and swimming mammals. Harmful effects on these animals can have indirect, harmful



ANKER ODUM

FOR THE YOUNGER READER

effects on humans. Sometimes the conditions in the water are bad enough to affect humans directly. Now we can establish whether a particular place is safe, that is unpolluted, for humans and other animals by the number and kinds of worms present. If the place is polluted, we can sometimes identify the pollutant from the worms that are present.

In more familiar settings, such as the garden and the compost heap, lots of worms tell us that things are working properly. A lot of worms in a spadeful of garden soil tells us that the soil probably has a healthy balance of minerals and organic material. We also know that the presence of worms will help to keep the garden soil healthy. The earthworms burrowing through the soil break up large particles and increase the pathways for air and water to get into and out of the soil. The earthworms also work plant litter from the surface down into the soil. Often, after a heavy rain, earthworms are found on the sidewalk, on the driveway, on the porch, or on the patio. By coming out of the ground in the daylight (unusual behaviour for earthworms), they tell us that water has filled their burrows, and that there is little oxygen for breathing in the ground.

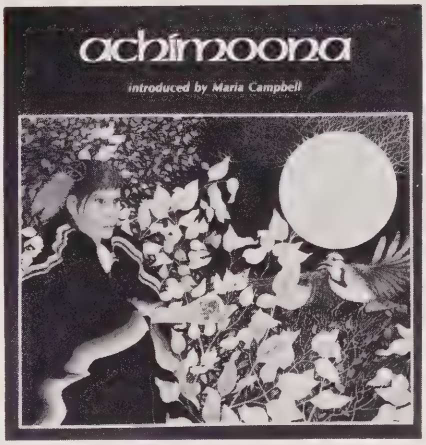
Another thing we are sometimes told by worms on the surface or by worms that we dig up is that they are ready to lay eggs. When earthworms and other oligochaetes are carrying eggs, a thickened, lighter-coloured layer develops over a region of the body located not too far behind the head. (The head is the pointed end that usually leads the way.) At this part of their body, a cocoon is secreted and then, after the secretion has toughened, eggs are laid into the case. The worm crawls out backwards leaving small holes at either end of the cocoon. Small worms hatch from the eggs some weeks later. Eventually these worms break out of the cocoon by wriggling about.

Worms can tell many things if their signals are received and correctly interpreted by other worms, animals, and man.

KATHRYN COATES

We Celebrate Spring
Bobbie Kalman and Karen Harrison
Crabtree Publishing Company
56 pp. $15.95 (cloth)

This fifty-six page, full-colour volume is one of five in Crabtree's *Holidays and Festivals Series*, which should appeal to audiences in Canada and in many other countries. *We Celebrate Spring* is packed with poems, stories, activities, and information about the traditions of spring in countries around the world. Readers will learn about characters such as Green George, events like Crazy Thursday and April Fools' Day—and the legend of Demeter and Persephone. The series could be particularly useful to school-children who are interested in special spring projects and games.
Recommended for grades three to five.



Achimoona
introduced by Maria Campbell
illustrations by various artists
Fifth House
98 pp. $19.95 (cloth)
$9.95 (paper)

This collection of stories comes from a group of native story-tellers who met with Maria Campbell to develop stories about Indians in contemporary situations. The collection includes eight stories, a poem, and artwork done by Saskatchewan native artists. It's an impressive production, one of the few which have come from native people themselves, speaking of their experience and understanding of the modern world. As such, it belongs on every library shelf.
Excerpt of review
Recommended for grades four and up.

Reviews reprinted from The Children's Book News *courtesy of The Children's Book Centre, Toronto.*

Calling Young Writers

Children between the ages of 9 and 14 years, who wish to submit short articles or poems about an experience at the Museum, may send their articles to *Rotunda*, Publication Services, Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario, M5S 2C6. No submission will be returned unless it is accompanied by a stamped, self-addressed envelope.

The Greek World, Early Italy and th

Paul Denis
Curatorial Assistant
Greek and Roman Department

The ROM's superb collections of Greek, Etruscan, and Bronze Age European artifacts will again be on display to the public, in their brand new permanent galleries. The galleries are arranged chronologically beginning with early Greece, after 1000 B.C. In the first gallery the visitor will be able to admire artifacts, mostly pottery, produced during the Geometric period, which dates from 900 to 700 B.C. The name of the period is derived from the linear geometric designs used in decoration. Of particular interest is a group of very fine vases from Athens, said to have been found in the tomb of a woman.

The adjoining gallery illustrates the subsequent Orientalizing period that lasted from about 700 to 550 B.C. During that time, Greek traders and colonists came into contact with the Near Eastern cultures of Asia Minor, Syria, Phoenicia, and Egypt. The meeting of cultures is clearly mirrored by the decoration found on Greek pottery. Fantastic creatures such as sphinxes, sirens, and griffins, as well as leopards and lions, populate the decorative bands on the vases. Perhaps the most important manifestation of this style is seen on the pottery produced in Corinth, fine examples of which are in the ROM collection.

Leaving early Greece, the visitor enters a large open gallery where the story of Greek creativity continues with the Archaic, Classical, and early Hellenistic periods, covering the years from about 600 to 300 B.C. This brightly lit area not only shows off the collection of Greek marble sculpture, but also displays with equal verve beautiful terracotta figurines, vases, coins, and jewellery. Images of man in Geometric and Corinthian art are always highly stylized. During the Classical period there was a great change: the human figure is no longer rendered as a simple stylized shape; instead, it is represented realistically though in an idealized manner. This period witnessed the birth of Western art. The gods were given a human form, but one of supreme majesty. The ideal of feminine beauty is perfectly embodied in a number of statues of Aphrodite. Later in the 4th century, sculptors, at times, imbued their work with pathos. The figures of a deceased woman and her servant girl on the grave stele of Iostrate easily convey this mood.

Left: Panathenaic amphora from Athens, 520 B.C., 62.3 cm high
Right: Red-figure *kantharos* from Athens, 480-470 B.C., 21.9 cm high

PHOTOGRAPHY DEPT, ROM

truscans, Bronze and Iron Age Europe

The two main types of pottery produced during the Archaic and Classical eras are displayed in separate areas. Black-figure vase painting, a style that was popular during the 6th century B.C., is presented along the west wall of the gallery. Most of the scenes on these pots are of Greek gods and heroes, such as Zeus, Hera, Dionysos, and Herakles. Red-figure vase painting was popular during the 5th and 4th centuries B.C. The fine examples on view along the east wall of the gallery show scenes taken from daily life.

Standing in front of the large terracotta case, the visitor is able to see the development of Greek sculpture, in miniature, from its earliest origins in the 8th century B.C. through the Archaic, Classical, and Hellenistic periods. A view of about seven centuries of Greek art is possible with a turn of the head.

The collection of Greek coins encapsulates the early history of Western coinage from the 6th to the 1st century B.C. Some of these tiny pieces of precious metal are stamped with images of such artistic merit that they equal and sometimes even surpass works of art of a much larger scale.

Tucked at the back of this large open gallery is a small annex devoted to public and political life in Athens at the zenith of her power during the second half of the 5th century B.C. Displayed here are a plaster cast of a metope from the Parthenon, a reconstruction of part of the coffered ceiling from the Propylaea, and the world-famous model of the Athenian acropolis with all of its buildings. A scale model of the Athena Parthenos, the gold and ivory cult statue in the Parthenon, is also exhibited in this area.

The story continues in the next gallery with the last phase of Greek art, the Hellenistic period, which began with the death of Alexander the Great in 323 B.C. and the subsequent division of his huge empire into smaller kingdoms, each ruled by a monarch. This era lasted for about three hundred years.

During this time, the Greeks showed a fondness for luxury items. One facet of this rich taste, the art of personal adornment, is on view in the jewellery case. At the same time, realism became just as popular in art as the representation of ideal beauty. Lifelike portraits, sometimes ugly, of the tough rulers are shown

Left: Red-figure *loutrophoros*, 450-440 B.C., 1.0 m high
Right: Grave relief sculpture of Iostrate, 4th century B.C., 1.35 m high

in the coin exhibit. Even a taste for the grotesque became widespread, especially in Alexandria. The case containing works of art illustrates this tendency. The Hellenistic world slowly came to an end as one by one the Greek kingdoms were defeated by Rome.

The next stop on the visitor's itinerary through the classical world is early Italy and Etruria. Artifacts in this area date from about the 10th century B.C. to the 2nd century B.C. In the field of ceramics the Etruscans developed their own type of pottery called *Bucchero* ware. As the collection shows, it came in a multitude of shapes and sizes. They were also very talented bronze workers. Numerous examples of this technique are on display: weapons, pots and pans, hand-held mirrors with finely engraved decorations, and votive statuettes. As for sculpture in the round, a 5th-century B.C. marble head of a youth is of particular importance because it is one of only a handful of marble sculptures from Etruria that survive today.

Some Etruscan art shows the influence of Greek art. This can be seen in a grouping of vases, which show stylistic affinities to Corinthian and Attic black- and red-figure pottery. Eventually the Etruscans were overcome by the might of Rome and their civilization came to an end.

The last gallery is devoted to the Bronze-Age cultures of Europe that existed in Britain, Ireland, France, Germany, and Switzerland from 2500 to 550 B.C. The exhibit shows fine examples of workmanship: weapons, horse fittings, and objects of personal adornment, some in gold.

A word of gratitude is expressed to Dr Elie Borowski for his generous loan of over twenty artifacts which include an important Greek bronze crater of about 550 B.C. and a beautiful late Hellenistic marble statue of the muse Erato.

The new Greek galleries are the fruit of three-and-one-half years of hard work on the part of the Greek and Roman Department, Exhibit Design Services, the Preparators, and the Conservation Department. We hope that the public enjoys visiting the new galleries as much as we enjoyed working on them.

PHOTOGRAPHY DEPT. ROM

Aphrodite of the Venus Genetrix type, 1st century B.C., 1.18 m high

▶The Greek and Roman Department has received a gift of five vases and two terracotta figurines from the collection of Dr Elie Borowski. One of the gifts is a unique early Etruscan jar with lid decorated in the Italo-geometric style, dating about 725–700 B.C.; another, an ornate black-gloss krater with added polychrome decoration comprising flying Eros figures, ribbons, and wreaths, produced in Italy around 300 B.C. Two vessels in Geometric style from Crete and a jug *(oinochoe)* in the Cumaean Late Geometric style are the other donated vases.

Both terracottas date from the Bronze Age. One is a late Minoan female head with a high headdress, created about 1400–1200 B.C. in Crete. It comes from a statuette of the type usually referred to as the household goddess. The other is a Mycenaean statuette of a goddess or female worshipper, dating from 1400–1300 B.C. In the large series of such statuettes this is an early and rather rare type, the so-called Proto-Phi type, so far unrepresented in the ROM collection, and for that reason more appreciated as a gift.

The Greek and Roman Department also has received three new acquisitions through the generosity of Robert E. Hindley. The first is an extremely fine bronze *sestertius* issued by the Roman Emperor Lucius Verus. The obverse bears his portrait; the reverse depicts a galley propelled over the waves by six rowers with Victory on the prow and a steersman at the stern. The second acquisition is a bronze statuette of a comic actor. The workmanship is of a very fine quality and the surface is covered by an attractive light green patina. The piece is Roman and dates from the Republican period, about the 2nd century B.C. Finally, the third is a sardonyx cameo showing a nymph and an infant astride a goat. The exquisitely rendered figures are carved in relief and appear white against a pale brown background. The cameo is late Hellenistic, dating to about the 1st century B.C.

PHOTOGRAPHY DEPT, ROM

Early Etruscan jar, 45 cm high

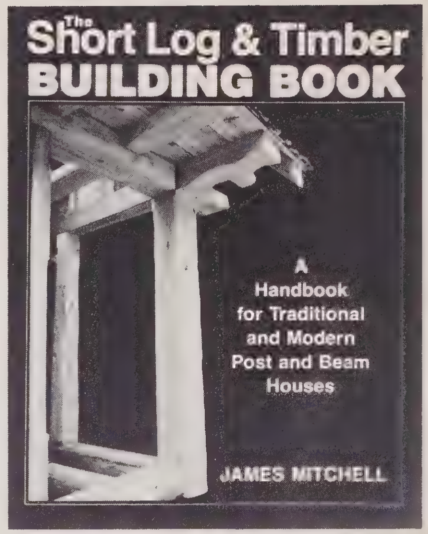
Cameo, 1.6 cm high

Statuette of a comic actor, 6.2 cm high

Black-gloss krater, 43.5 cm high

Statuette of a household goddess, 15.5 cm high

Sestertius showing reverse side, 3.28 cm high



The Short Log and Timber Building Book
James Mitchell
Hartley & Marks Ltd.
282 pp. $14.95 (paperback)

Reviewed by Dr Walter A. Kenyon, former curator of archaeology, ROM

It may seem odd to find a "how to" book reviewed in *Rotunda*, especially by an archaeologist. I first glanced through the book because I happen to be interested in the history of wooden architecture. Suddenly a passage caught my eye that made me pause for a closer look. The author points out that log architecture had virtually died out by the end of the last century, but there was a sudden revival in the mid–1960s. He attributes this to a social upheaval in North America, an upheaval that challenged many accepted values. In his words:

> Individuals began searching for methods to reaffirm their severed bonds with nature. They began to question the notion of a mortgaged society and sought alternative methods of housing. As a direct result, traditional skills were reintroduced and combined with modern technologies to produce a new breed of owner-built housing.

Such insights bear directly upon a persistent problem in northern Canada: the desperate need for suitable housing on Indian reserves.

At present, the common way to produce native housing is to have the logs cut and milled in the south,

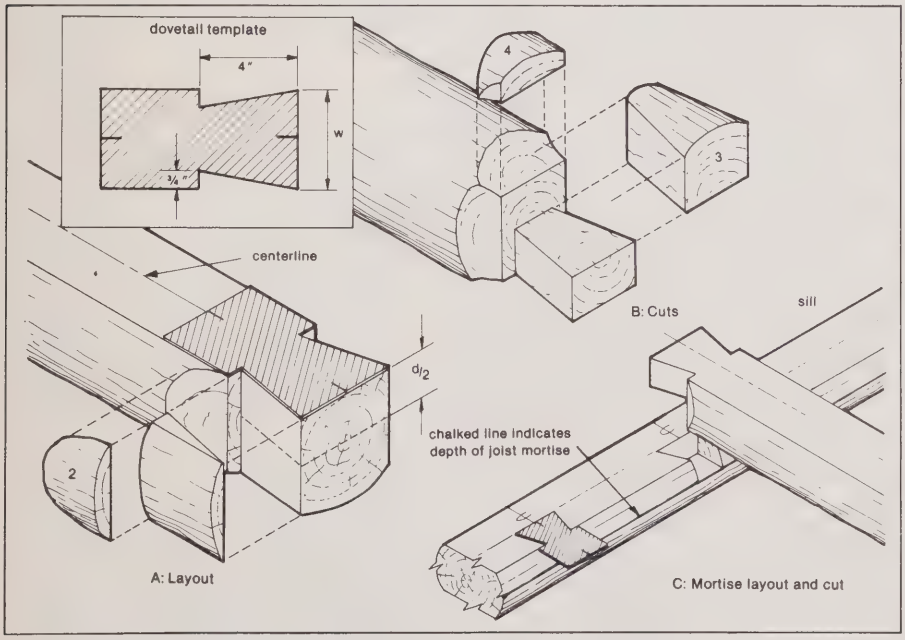
and then the joists, studs, and rafters are moved north, frequently by air, and framed into houses. The result of this system is expensive, prefabricated slums that must surely be as depressing to the human spirit as they are to the human eye. They bear no discernible relationship to the lives or the sentiments of the people who are destined to live in them; nor do they bear any visible relationship to the environment in which they are placed.

There is yet another objection to this arrangement. Most of the jobs are located in the south, and the money for building supplies and air freight is spent in the south. It is certainly anomalous that the large and lucrative business of providing Indian housing does so very little for the Indian either economically or spiritually.

Across all of western Europe there are hundreds of log and timber structures that were built between the 13th and 20th centuries, and they are still in use. By and large, they were built by people who used simple tools, nothing more complex than an axe, a saw, and a chisel. Surely European trees are no more durable than Canadian trees, and anything that a Swede, a Finn, or a Russian can do with an axe, a Canadian Indian can do just as well.

Mitchell, by the way, makes no mention of either Indians or Indian housing. But Indians must be included in his audience because he is writing for all people who want to reaffirm their severed bonds with nature by building log houses. He assures the reader that even such esoteric matters as architecture need not be left to the specialist. He recommends, in fact, that the builder do his own designing, for only in this way can the house truly reflect the needs and the sentiments of the people who will live in it. Mitchell also advises the owner-builder to choose his own site to ensure that the three elements—the builder, his home, and its setting—are harmonious.

Mitchell provides the reader with step-by-step instructions for designing and building log and timber houses. His book is logically written, well illustrated, and it warns the reader of any major pitfalls that might be encountered. This is a "how to" book written by a man with the insight that comes only from years of experience and an abiding interest in the structural and aesthetic qualities of wood. However, this book also is an expression of concern for the nurturing of the human spirit. James Mitchell's volume should be described most accurately as a guide to spiritual carpentry.



This book has detailed diagrams that even a beginner can follow.

Patterns of Power/Vers la force spirituelle
Dr Ruth B. Phillips
The McMichael Canadian Collection
151 pp. $20.95 (cloth)

Reviewed by Barry J. Martin, who teaches a course on Indian and Inuit mythology and ritual for the School of Continuing Studies, University of Toronto

Patterns of Power is the handsome catalogue of the exhibition of the Great Lakes native artifact collection or "cabinet" of Colonel Jasper Grant. The exhibition was mounted by the McMichael Canadian Collection and organized by Dr Ruth Phillips to celebrate the bicentennial of Ontario. Colonel Grant took the collection to Ireland, when he returned after his stay in Canada from 1800 to 1809. Grant had been stationed at Fort George on the Niagara Peninsula and Fort Malden at Amherstburg, which were regularly visited by large numbers of natives from various tribes: Ojibways, Iroquois, Chippewas, Potawatomis, Ottawas, Miamis, and others. Grant died in Ireland in 1812, and his heirs deposited the fifty-nine items in the National Museum of Ireland in 1902, soon after its establishment. These objects and others from the Royal Ontario Museum, the National Museum of Man, and the McCord Museum made up the McMichael exhibition.

The short, informative text, published in English and French, includes accounts of Grant's reminiscences of his official duties, social life in Upper Canada, the land, the natives, and his collection of botanical specimens and native artifacts or "artifical curiosities" as they were called. The appendices are important historical and ethnographic documents. Appendix I is a letter from Grant to his brother in which he describes native life, detailing hunting patterns, physiognomy, clothing, and his impressions of native feelings towards the "whites". Appendix II is a first-hand account by Edward

Walsh, a surgeon in the 49th Regiment of Foot, of an eastern Great Lakes' Midewiwin ceremony. The initiation of a member of the Midewiwin or Grand Medicine Society took place on the Grand River in 1804, and this document is one of a few rare and early narratives on shamanic practice. Appendix III is the short address of the Ottawas, Chippewas, and Potawatomis to Colonel Grant on the occasion of his leaving Fort Malden.

All ninety-four items that were in the exhibition—clothing, belts, pouches, woven bags, moccasins, pipe bowls, and war clubs—are illustrated, twenty-four in colour. Each piece is dated and described, and given its probable tribal attribution. One serious problem for the reader, when referring from the text and the itemized descriptions to the illustrations, is that the illustrations are not in chronological or any other obvious logical order, and therefore they are difficult to find. It is also unfortunate that some objects remarked upon for their colour are reproduced in black and white.

The collection is superb. The artifacts are important for anthropologists, historians, and museologists, and for native people who are rediscovering their heritage. There are excellent and, in some cases, unique examples of early 19th-century Great Lakes native functional artifacts. Period paintings of native people from southwestern Ontario such as the *Dance of Indian Women* by George Heriot were added to the exhibition and included in the catalogue to help the visitor and the reader to picture the historical and cultural contexts of the artifacts. The text on native life, cosmology, dreams, shamanism, art symbolism on pouches, and art in general is concise and informative.

Patterns of Power/Vers la force spirituelle brings old artifacts to life for us, and helps us to appreciate the beauty of native creations used in the daily existence of the Indians of the Great Lakes region. It is a special opportunity to encounter anew the depth of spirituality and the vision of life of the native peoples.

On The Beach

ANKER ODUM

1. The most famous footprint in the sand must be the one found by Robinson Crusoe. To have been so well preserved, the print must have been made in the dark wet sand near the water. And had Crusoe been there when Friday left the print, he would have seen the sand immediately around Friday's foot turn white as his foot pressed into the sand. Why is wet sand darker than dry? And why does the wet sand around your foot turn white as you stand on it?

2. You're walking down the beach, and you notice a striking individual seated between two people, also very attractive. The strange thing is, you remember seeing the middle person before, and thinking that he or she was nothing out of the ordinary. What has happened?

3. Two Ohio men in their late thirties, Jim Lewis and Jim Springer, vacationed on the same three-block-long stretch of beach of Florida's Gulf coast one winter. This is not too remarkable, except that both these men chain-smoked Salems, drove Chevrolets, and didn't like baseball. In fact, the coincidences in their lives have made them the object of much scientific interest. Why?

4. Each year about seven hundred and fifty people in North America are stung by sting-rays. The ray, a flattened creature with poisonous tail spines, is usually lying quietly in shallow water, half-buried in the sand, when the unwary wader treads on it. The sting is extremely painful, but the treatment is surprisingly simple. What is it?

5. Here is a quick question. The particles of light (photons) from the sun that strike your skin at the beach, giving you that wonderful August tan, took eight minutes to cross the ninety-three million miles of space between the sun and the earth. How long did it take the photons to travel from the centre of the sun to its surface? (a) ten seconds, (b) a year, (c) a million years?

JAY INGRAM

The answers are given below.

1. Dry sand appears white because there is a lot of light reflected back to your eyes from the crystalline surfaces of the grains. If the sand is wet, however, the light no longer follows a simple straight path between the grains of sand and your eyes. It is bent as it passes through the water; then, it is scattered at the air-water surface as well as the water-sand surface. The result is that less light actually comes back to your eyes and so the sand looks darker. This would suggest that as you press your foot into dark wet sand it turns white because it is drying. That is correct, but it's not because you've pressed the water out of the sand. What really happens is subtler. There is little space between sand grains even when they're dry, and wet sand is even more compact; the water provides a kind of electrical glue between the grains. When you step down, the force you exert just can't move the grains any closer together. Instead the sand is pushed up around your foot. But much of the water in the spaces between the grains is left behind, and until it soaks up through the sand by capillary action, the sand looks white.

2. A series of studies by psychologist Ed Geiselman has shown that people are judged more attractive (by a panel of volunteers) if they are between two attractive people. The opposite effect, lessened attractiveness if between two unattractive people, also exists but isn't as strong. So your judgement of the person in question is being influenced by the presence of the two other people. (Somehow it's no surprise to learn that these studies were conducted in Los Angeles.)

3. The two Jims were the first, and most famous example of identical twins who were separated at birth, and then reunited many years later. The parallels in their lives are startling: they both suffered the same kind of headaches, gained weight at the same time in their lives and then maintained it, and scored as close in personality tests as would the same person taking the test twice. They both married twice, their second wives both were named Betty, they both had owned dogs named Toy, and each had a white bench around a tree in his front yard. The two Jims and several other pairs of twins like them fascinate behavioural scientists because they suggest there is a strong genetic component to behaviour.

4. If stung by a sting-ray, the key thing is to flood the cut—and it can be a deep, ragged laceration—with water that is as hot as you can tolerate. Hot water will deactivate the toxin by changing its structure permanently, in the same way that you change the proteins in egg white by putting them in hot water. There are, of course, other medical precautions to take, like cleaning out bits of the stinger if they are in the cut. However, the sooner the hot water is poured on, the better. It is a good way of taking advantage of the fact that sting-ray toxins are designed to do their damage at the temperature of sea water.

5. A million years. The photons produced in the core of the sun by the fusion of hydrogen atoms take a very tortuous route to the surface. They are absorbed momentarily by one atom, then radiated away only to be absorbed by another. Their path to the surface is random, and so extremely slow.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